PACIFIC DISCOVERY

FIFTY CENTS

Science
Exploration
Nature
Geography
History
Man

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CALIFORNIA ACADEMY OF SCIENCES

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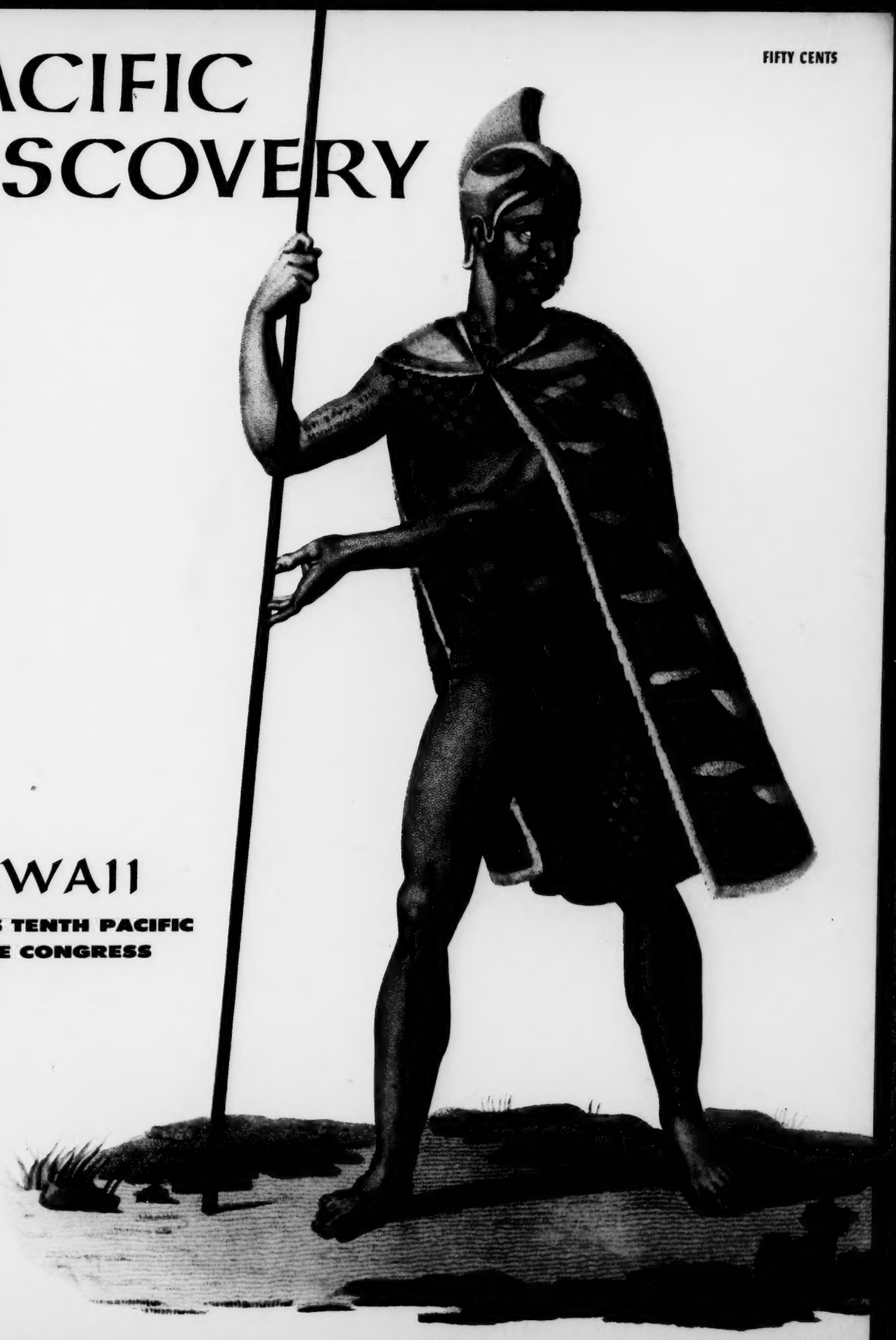
VOLUME XIV
NUMBER 5



HAWAII

WELCOMES TENTH PACIFIC SCIENCE CONGRESS

SEPTEMBER–OCTOBER 1961
VOLUME XIV • NUMBER 5

PACIFIC DISCOVERY

PRE-DISCOVERY

HAWAII, here we are!—twelve hundred men and women from all nations around and within the Pacific Ocean, and from nations not touching the Pacific but having certain scientific commitments in this hemisphere of water. Most of us are professional scientists, actively engaged in research; a few, like the editor of this magazine, have something to do with getting the story behind the research and a digest of its results into the public eye. For science editors and writers any such gathering of hardshell, practicing scientists is a golden opportunity to preview stories of scientific discovery in the making. To hold this meeting in mid-Pacific, in such surroundings and among such hospitable people, is a golden experience and a privilege for which, Hawaiians, we thank you. . . . ¶ Speaking for *PD*, we thank all those who have helped to make this special Hawaii issue a reality: all who appear in name, and several who do not. Particularly helpful, in responding to urgent, last-minute requests from the editorial desk were Miss Margaret Titcomb, Librarian of the Bishop Museum, and Edwin H. Bryan, Jr., curator of collections and Manager, Pacific Information Center, at the Museum. Special thanks should go to those who willingly supplied material, at the request of the Museum's Director, Dr. Alexander Spoehr, acting in our behalf, which for lack of space only could not be included (what to leave out was the editor's decision and hardest choice; and at this point also we wish to state that the responsibility for any editorial or typographic slips that may have crept into these pages rests on the same desk, and can be excused in part only by the stepping up of the schedule to meet a ship for Honolulu). We thank Art. Hansen, Public Relations, Castle and Cooke, Ltd., for photos on pages 12–13, and emphasize the fact that their use in the present context is in no way intended to reflect upon the land-use practices of that respected firm. Finally, thanks to Gillick Printing, Inc., and California Art & Engraving Co., both of Berkeley, who gave us their unfailing top quality and service under unusual pressure.

PD'S AUTHORS

FOR THE PAST 15 years **Thomas Nickerson,** Hawaiian since 1929, has been Director of the University of Hawaii Office of Publications and Information, was promoted August 1 to become Assistant to Provost Willard Wilson. . . . **Dr. David I. Blumenstock,** Pacific Area Climatologist, U.S. Weather Bureau, is author of *The Ocean of Air* (reviewed on page 35). . . . ¶ Former science writer **Hugh Lytle** is Bishop Museum Public Information Officer. . . . ¶ **Richard E. Warner,** now teaching assistant in zoölogy at the University of California, Berkeley, was formerly in the Entomology Department of the Hawaiian Sugar Planters' Association, and on the staff of the Hawaii Board of Agriculture. . . . ¶ **Dr. Paul R. Weissich** is Director of the Foster Botanical Garden, Honolulu. . . . **Drs. Otto and Isa Degener,** botanists, live in Waialua, Oahu, and together publish *Flora Hawaiiensis*, with a new volume now in preparation. . . . ¶ Since becoming its Director in 1953, the noted Pacific anthropologist **Dr. Alexander Spoehr** has raised Honolulu's Bernice P. Bishop Museum to new heights as a center of Pacific science. In January 1962 Dr. Spoehr will assume chancellorship of the University of Hawaii's new East-West Center (see editorial), a task that will make full use of all his experience and interest in the farthest Pacific and Southeast Asia. . . . ¶ Also a Pacific anthropologist and archeologist of distinction is **Dr. Kenneth P. Emory,** on the Bishop Museum staff since 1920 (he grew up in Hawaii). His archeological work now covers both Hawaii and Tahiti. . . . ¶ Hawaiian Goose Wildlife Biologist **David H. Woodside** has been in charge of the Nene Restoration Project on the Island of Hawaii since 1953. . . . ¶ **Dr. Earl S. Herald,** Curator of the Steinhart Aquarium, California Academy of Sciences, San Francisco, is much at home in Hawaiian and other tropical Pacific waters—he is a skin-diving ichthyologist, author of *Living Fishes of the World* (see Reviews). . . . ¶ Now a professor at Alameda State College, our nature editor **Dr. Arthur C. Smith** made the most of war-time duty tours to become well acquainted with Hawaiian nature. . . . ¶ **George W. Bunton** is Curator of Astronomy at California Academy of Sciences, San Francisco. D.G.K.

IN THIS ISSUE

THE COVER

"UN OFFICIER du roi en grand costume," drawing by Jacques Arago in *Voyage autour du monde . . . sur les corvettes de S. M. l'Uranie et la Physicienne, pendant les années 1817, 1818, 1819, et 1820* . . . par M. Louis de Freycinet, Paris (1825). (Donald Angus Collection, Bishop Museum, Honolulu)

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A JOURNAL OF NATURE AND MAN IN THE PACIFIC WORLD

EDITORIAL "ABOVE ALL NATIONS IS HUMANITY"

IT WAS MANY YEARS AGO that these words were inscribed on the gates to the University of Hawaii. They were indicative of the spirit of mutual respect with which the people of many nations who have settled in Hawaii regard each other. But the inscriber hardly could have anticipated the tremendous opportunity for service to humanity which Congress was to offer America's newest state.

This inspiring responsibility was thrust upon Hawaii last fall when Congress passed the first of three annual appropriations of $10 million to establish a Center for Technical and Cultural Interchange between East and West on the campus of the University of Hawaii. But the East-West Center is quite as much a tribute to the character of the community as it is to the University's deep and longstanding interest in the cultures of Asian countries, evidence for which is found in the more than 100 courses related to Asia listed it is general catalogue.

A dramatic example of the community's keen sense of responsibility for making the most of opportunities to promote intercultural exchange was offered when 106 persons and business establishments recently contributed $1,000 each to finance the fourth in a series of East-West Philosophers' conferences which the University has conducted at ten-year intervals since 1939. This unprecedented support will permit careful advance planning and the scheduling of the conference in 1964, five years earlier than originally planned.

It is into the hearts and homes of such generous and serious-minded citizens that more than 100 East-West Center students from Asian and Pacific countries are being welcomed. At the end of five years, this number will swell to 2,000 of these highly qualified and federally financed Center students.

Their reactions to Hawaii follow the pattern set by the mainland-bound graduate students who for eight years now have attended the six-week Asian Orientation Center which the University has conducted on behalf of the Department of State. They find Hawaii's climate much like their own. The faces of the Friends of the East-West Center that greet them at the airport are familiar to them and make them feel immediately at home. So are the foods they find in the restaurants, the languages they hear spoken in the hotels, even the fashions displayed in the shops.

Curiously enough, they find far greater affinity between the Asian elements in Hawaii's population than now exists between the citizens of the various Asian countries. For one thing, inter-racial marriage is far less frowned upon in Hawaii. Indeed, Hawaii's people of mixed ancestry are among her most prepossessing citizens. A sociologist has remarked that as one strolls through the streets of Honolulu one obtains a preview of the ultimate "world man"—the single race that will walk upon the earth once all racial barriers have broken down.

It is an intriguing record, worthy of careful scrutiny: the way in which the demand for field workers on the sugar plantations brought wave after wave of Asians to Hawaii's shores—Chinese, Japanese, Koreans, Filipinos; how they managed to get along together; what happened to them over the years; how they eventually contributed to a coöperative amalgam that sets a standard for the world.

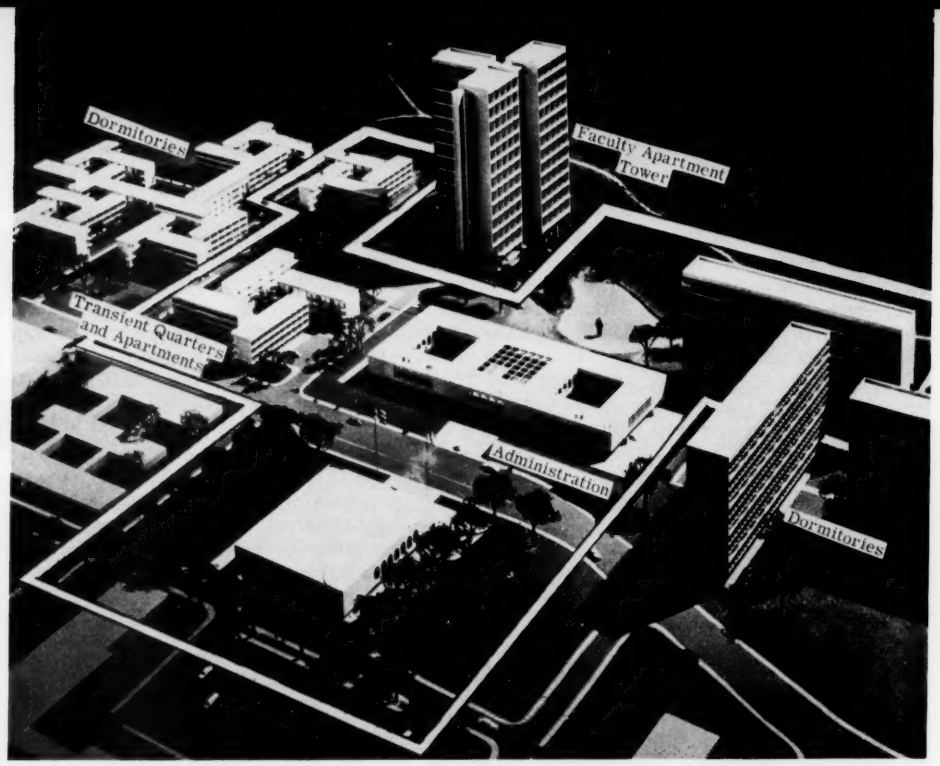
The opportunity for such study in what has been referred to as "Hawaii's Living Laboratory of Sociology" has by no means been overlooked by Hawaii's university. An outgrowth of such studies was the Conference on Race Relations in World Perspective which the institution conducted in 1954 in coöperation with the University of California and the University of Chicago. Attended by scientists and race administrators the world over, it resulted in a significant volume of papers bearing the title of the conference and in better exchange of information between those working in this field.

Lessons gained from Hawaii's experience – the trauma, frictions, loyalty tensions, frustrations, mental conflict (or, more significant, the relative absence of them)—are of practical value in regions of the world where the masses are on the march, where urbanization, industrialization, and political independence pose difficult problems. The University's Social Science Research Institute is making valuable contributions toward the charting of a safe course among these perils.

But what strikes the Asian student most forcefully is the unimpeachable evidence that manifests itself, wherever he looks, of the way in which citizens of his racial stock, whose grandparents came to Hawaii as agricultural laborers, have prospered under the opportunities offered him by the American way of life. Socially, professionally, economically, politically, third-generation citizens of Asian ancestry now occupy responsible and respected positions in the community. This is a self-evident fact that requires no labored documentation. One need only read the social columns of the newspapers, consult the classified pages of the telephone directory, or review the roster of business leaders, state legislators, and delegates to Congress. The names there entered speak for themselves—Lam, Mirikitani, Kim, Kai, Sogo, Miho, Ho, Ching, Miyake, Fong, Inouye. They appear among Hawaii's long-established Anglo-American names—Dillingham, Castle, Cooke, Alexander, Baldwin. A startling fact is that last year in terms of average income by ethnic groups, Hawaii's Chinese overtook Hawaii's Caucasians.

Improved status of Hawaii's Asians has not been achieved at the sacrifice of their cultural heritage. Asians in Hawaii are proud of their traditional drama, art, literature, and music. They have been generous in their donation of books to the University's Oriental Collection. They patronize Asian films, the Noh and Kabuki drama presented by the University Theatre Group, and the outstanding exhibits of Asian art treasurers tastefully exhibited by the world-famous Honolulu Academy of Arts.

An initially startling observation is frequently made by students from the Far East. They state with con-



Center for Cultural and Technical Interchange between East and West on the campus of the University of Hawaii—architect's scale model. (University of Hawaii)

(University of Hawaii photo by Masao Miyamoto)

siderable enthusiasm that at home they never had the opportunity of learning so much about their own Asian neighbors as they do in Hawaii.

East-West Center scholarship students from the West—from Hawaii and the other states (they are admitted on a ratio of one to four)—have this same opportunity. Open to them, as to 8,000 regular students attending the University, is the Asian Studies Program and the Overseas Operations Program which prepares the representatives of government agencies, private enterprise, and foundations for service in Asia. The Center is strictly a two-way street. Intercultural conferences on many levels are making known the problems which confront the nations on both sides of the Pacific. Though many of these problems are common to all, the means by which they are to be met are not necessarily uniform. Understanding, not agreement, is the goal. The man of the East and the man of the West need not see eye to eye. It is sufficient that they look in the same direction—toward international understanding and world peace. Herein lies the greatest hope for international security. Herein lies the unique and almost staggering opportunity for service to world freedom by the nation's newest state.

Thus while tall hotels are forming a fringe along the beaches of Oahu on behalf of the thriving tourist trade, deep in green Manoa Valley, on the Rainbow Campus of the University of Hawaii, high-rise dormitories are being erected to house the swelling ranks of Asian and American students and scholars. In them will be reposed solemn hopes for greater understanding between the divergent nations that make up mankind. This is Hawaii's unique contribution to the Pacific area.

THOMAS NICKERSON

East-West Center students leaving the University's Hawaii Hall (*left to right*): Naomi Fujita, Japan; Muriel Akana, UH Campus Guide; Reiko Mochinaga, EWC scholarship student, Japan; Jeanne Getchas, UH Campus Guide; EWC scholarship students Chhom Reak Thong, Cambodia, Ouphet Souvannavong, Laos, and Takashi Yoshikuni, Japan.

Climate by the Mile

THE CLIMATE of Hawaii is a major aspect of its total personality. Just as it is impossible really to know an individual without knowing his changing moods, so one does not know Hawaii until he has seen and felt and reacted to the many kinds of weather that give character to its climate.

To those from other climes who have not lived in Hawaii it is often difficult to explain that the Hawaiian climate offers a variety of weather scenes that in their own way are just as diverse as the scenes of higher latitudes, even though more subdued. Knowing that Hawaii is in the tropics, the stranger is apt to think that just as the travel literature says these islands are constantly bathed in sunshine and engulfed by gentle tradewind air. Or the stranger may have retained the vivid impressions created by Somerset Maugham's *Rain,* and so may think that for week after week the rain pours down unceasingly.

In fact, sunny tradewind days and occasional tor-

DAVID I. BLUMENSTOCK

rential rains are important elements of the Hawaiian climate. But they are not the only elements nor do they bring out the most fundamental and astonishing trait. This trait is the variation in weather conditions from one place to another. At any given moment, in one locality there may be full sunshine and winds so small as to be barely felt while in another locality less than a mile away the sun is hidden, the rain beats down and the wind rips the weaker fronds from the coconut trees. A contrast of this kind is not unusual even though both localities are near sea level. Even greater contrasts exist when one compares the weather of the lowlands and the higher mountain slopes. Then a simultaneous view of the existing weather might show areas at elevations of a few thousand feet immersed in clouds, patches of snow at 9,000 feet, and mountain passes scourged by wind and rain.

Plotted on a map, the climatic averages reflect the sharp areal variations in climate even though they fail to reveal the magnitude of the striking differences that exist at any moment. On Mount Waialeale on Kauai the rainfall averages 460 inches a year; yet only two miles away the average is only 150 inches. This extreme example represents a rainfall gradient of 120 inches for every mile traversed or of seven inches over a distance of 300 feet, the length of a football field.

Even within the city of Honolulu proper the rainfall gradients are extreme. At Waikiki the rainfall is 23 inches. On the University of Hawaii campus in the lower Manoa Valley it is about 40 inches. Three miles away farther up the valley, it is over 100 inches. These averages reflect the fact that often with continuous showery rainfalls in the upper valley there are only intermittent showers in the lower valley, while at the same time there is at most an evanescent shower in Waikiki, a shower so brief and light as to leave no trace of moisture upon the sidewalk five minutes later. Speaking of New England's climate, Mark Twain said, "If you don't like the weather, . . . wait a few minutes." The Hawaiian might say, "If you don't like the weather, walk a mile."

Conditions of rain and cloud and wind change sharply from place to place; yet the temperature of the air does not. Everywhere near sea level the land is immersed in warm mild air from off the ocean. In winter as in summer the temperature averages in the middle to low 70's, yet extremely hot days are rare. Even so, when, as occasionally happens, the temperatures are in the high 80's or very slightly above, the weather may be uncomfortably hot because of the high humidity, especially if the tradewinds have ceased to blow. And at night if the temperature drops to the low 60's or slightly below, as it sometimes does, the damp mild air seems sharp and cold if the wind is blowing and if the observer is one who has become accustomed to the usual genial warmth.

For marked temperature contrast one goes to the mountains. On the higher slopes of Mauna Loa and Mauna Kea night-time temperatures are frequently below freezing and sometimes below 20 degrees, while even at elevations of a few thousand feet the air is decidedly cooler than at sea level. Thus, though the lowlands fall heir to the warmth imported from off the ocean by the tradewinds, the mountains at height do not. For the air that surrounds the mountains arrives as air aloft that has cooled through having risen above the ocean surface or up-slope across the land.

The tradewinds are a dominant motif of the Hawaiian climate. From May to September, which is the summer season, they blow over 85 per cent of the time, and from October through April, which is the winter season, over 65 per cent of the time. These are the two Hawaiian seasons. And there are only two. The Hawaiians called them *kau* and *hoo-ilo* and they knew that *kau* was the season of the trades with only light showers in the lowlands though with frequent heavy showers in the mountains. They knew also that during *hoo-ilo,* whereas the tradewinds were often interrupted by contrary winds, this season also held the

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These photos were taken a few minutes apart on the afternoon of 22 July. There was a slight buildup of clouds over the Koolau Mountains, with intermittent showers, as seen from the windward—east—coast of Oahu. This was a tradewind day, though not wholly typical as there were relatively few fair-weather cumulus clouds over the ocean but were, instead, patches of middle clouds such as those showing through the palms. (There was probably a slight disturbance in the area, but not intense enough to produce rain in the coast areas.)

The major significance of the contrasting photos is the difference in cloud formations as indicative of differing weather beneath the clouds—fair, warm, balmy, with no rainshowers along the coast, light tradewinds; showery weather in the mountains and along adjacent slopes. Cloud forms change constantly, of course; but they change with particular rapidity near and over the mountains and a photo taken a few minutes later may well have shown showers actually in progress over the mountains (with rain plumes descending to the mountain slopes).

Even on fair weather days, contrasting cloud patterns reveal marked weather differences from place to place.

↑ Billowy cumulus clouds over the mountains signify intermittent showers, while at the same time—

→ The weather is fair over the sea, with only light, scattered clouds at height (altocumulus and altostratus).

(Photographs by Gordon Morse)

strongest tradewinds of all. They knew that this was the season of occasional torrential rainstorms that might last for one day, two days, or even more.

Thus the Hawaiian climate is one of seasonal contrast as well as contrast from place to place. Yet the seasonal contrasts are differently expressed from one location to another. In the slightly warmer summers the visitor or resident may go to the mountains, but there he will find more rain unless he moves far up the slopes of the very high mountains on Hawaii and Maui. In the winter, he may move to such dry areas as the Kona coast of Hawaii, where the rainfall is usually less than in other coastal areas. Whichever the season, he can always change the character of the climate that surrounds him simply by traveling a few miles, in one direction or another.

HUGH LYTLE

a Drop to Drink

WATER FOR ISLAND THIRST

WHERE do almost two-thirds of a million people in the mid-Pacific get their water?

The populations on the separate Hawaiian islands have varying problems. The biggest problem, which is met successfully, is encountered by those living on the island of Oahu, most of them in Honolulu. There, some 500,000 people draw about 60 million gallons of water daily from underground sources for domestic and business purposes. An estimated 450 million gallons daily in addition is used for irrigation of sugar and pineapple, the main crops.

Oahu, along with some other volcanic islands, is lucky in that the lava of which it is formed is highly permeable. When rain falls, it seeps downward to settle on the salt water that has moved in from the surrounding Pacific Ocean. This unusual water source is tapped by means of wells and vertical or inclined shafts with horizontal collecting tunnels at sea level. Tunneling directly into the mountains at high elevation provides an additional source of water, one that does not rest on salt water.

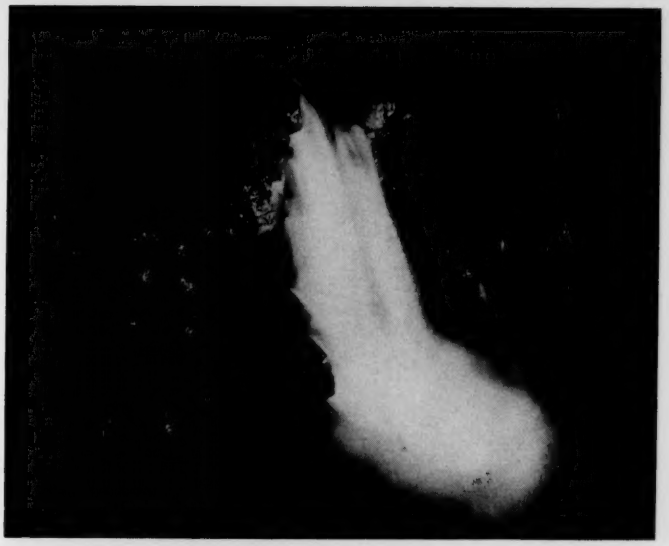
The ability of the fresh water to float on salt water results from the elementary principle of buoyance which states that a lighter fluid (fresh water) will float on a heavier fluid (salt water). The boundary between the two fluids is not perfect, however, and there is a layer of brackish water between them, the result of their mixing, which may be several hundred feet thick. Because of the sensitive balance between the fresh and salt waters, the Board of Water Supply, headed by Edward J. Morgan, manager and chief engineer, takes elaborate precautions to prevent an overdraft of fresh water. If the salt water were to rise it would ruin Honolulu's water supply for years, perhaps for centuries.

This underground water supply is shaped somewhat like a lens. The phenomenon, indeed, is called the Ghyben-Herzberg lens after two scientists, Dutch and German, who recognized and described it about 60 years ago. The lens shape results because of the movement of vast quantities of fresh water from inland toward the coastal rim of the island where it discharges into the sea. At the coast a thick wedge of nearly impervious "caprock" retards the fresh water flow, thus forcing the lens to thicken.

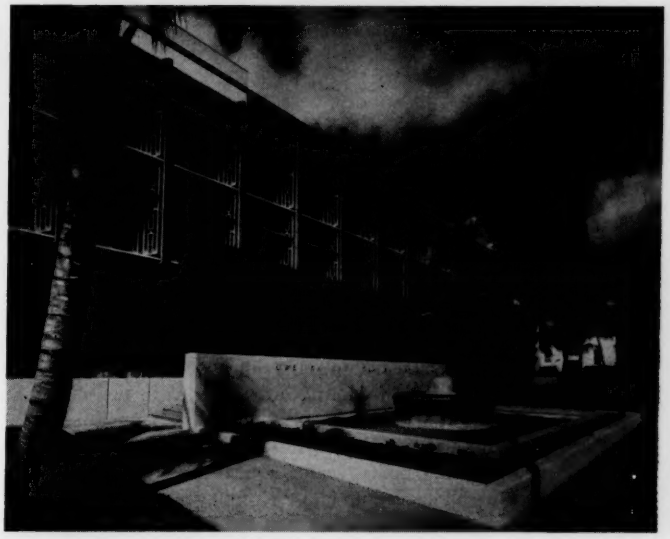
Honolulu's water supply, with minor exceptions, requires no treatment at all. It is neither filtered nor chlorinated.

It is rainwater that has fallen in the rugged mountains behind the coastal plains. It is ready to use, once our engineers found out how to get to it and conserve it.

Edward Morgan says the supply is assured indefinitely, provided the sound development and management practices that have prevented the uncontrolled intrusion of sea water are continued.

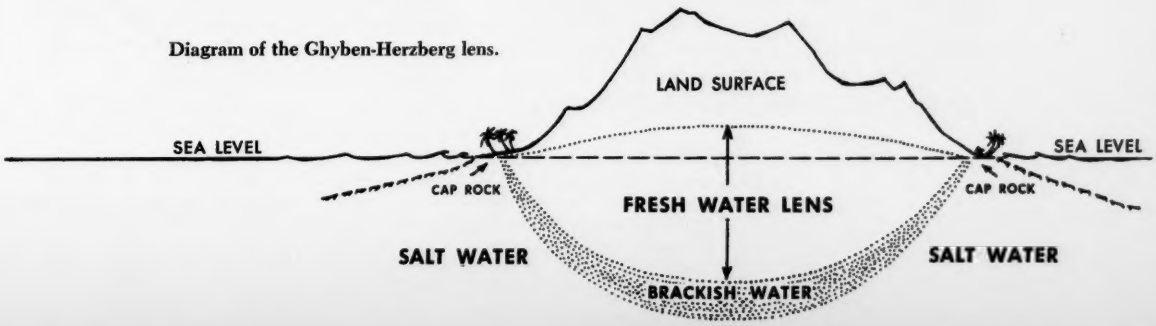


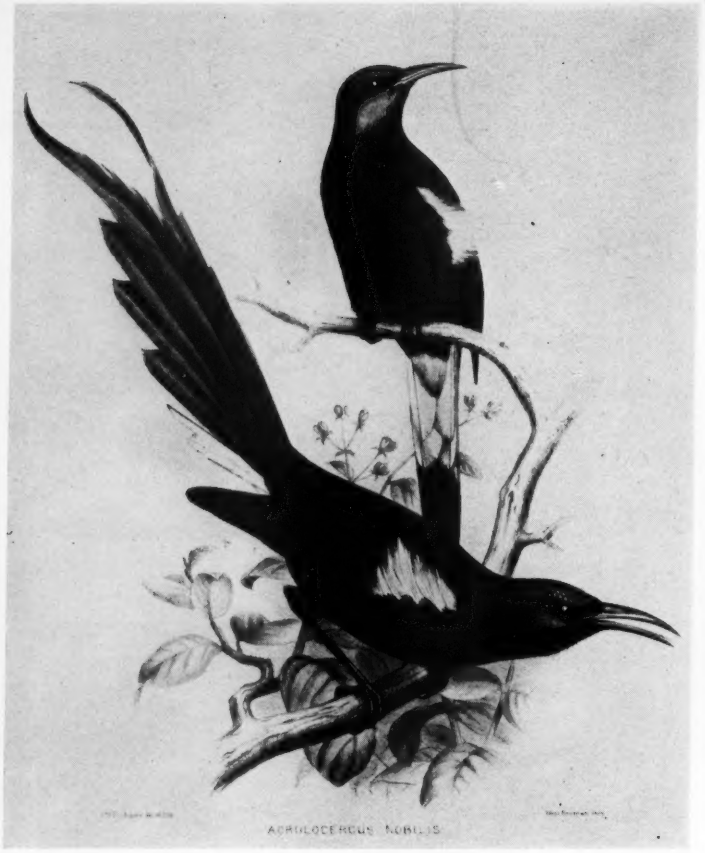
Underground catchment basin, Oahu. (BWS, Honolulu)



Headquarters, Board of Water Supply, Honolulu.
(Official photo by R. Wenkam, Honolulu)

Diagram of the Ghyben-Herzberg lens.





HAWAII'S BIRDS—1

AT FIRST there was nothing; only the gray rolling Pacific Ocean, stretching westward around the globe from western North America to the shores of eastern Asia.

Then one day, amidst a confusion of steam and seething, boiling water, a great mass of tortured black basalt heaved up into the cooling air. In the days, and years, and centuries that followed, the process continued. First at one point, then at another, along the great rift or volcanic rupture stretching for nearly 1,600 miles from northwestward to southeastward across the mid-Pacific Basin floor, the molten lava came flooding up from the sea. So it was—the process still continuing on the Big Island at the far southeast—that the Hawaiian Islands were born.

Eons passed. The lava cooled, was rained upon, eroded. Occasional spores of ferns, wafted across the oceanic vastness, lodged in the new rock; a few found footings and germinated. Less often still, plant seeds—by means we only surmise—found their way to the barren, treeless shores. From these early colonists, arriving sporadically at a rate of one each 30,000 years through a million centuries, the uniquely strange Hawaiian native forests evolved. A lobelia seed, its original home apparently in Africa, arrived somehow and found the young islands favorable. From that single immigrant form there gradually developed 23 distinct species, endemic to the nascent land. Some of the new lobelias had long, curving, tubular flowers with abundant nectar. They would provide a rich food source for bird species yet to come. The fortuitous arrival of some kind of violet into this fertile yet under-planted garden permitted another burst of adaptive change, this colonist giving rise to strange shrubby forms far removed in appearance from the common violet.

Into this bizarre assemblage of botanic vagabonds the wind from time to time deposited some feathered waif, or perhaps a small flock, lost and carried off-course by one of the great Pacific storms. So casual was this process of avian introduction that it might be called insignificant, but that occasionally one such wanderer found food, lived, and became established. There were not many of these successful colonists. In all we can conclude—mostly through evidence obtained by the early ornithologists and skin collectors—that about 16 separate immigrants won a permanent foothold. From these colonists evolved 70 en-

RICHARD E. WARNER

demic forms, species unique to the Hawaiian environment. It is possible that other species did take hold now and then, only to be wiped out before becoming well established.

While it is not our purpose to examine in detail the complexities of evolution of the Hawaiian avifauna,* a few brief illustrations may help to show the marvelous results of adaptive radiation so classically presented in the endemic Hawaiian birds. Indeed, Hawaii has the distinction (ignored and abused for many years now) of having perhaps the most extraordinary native bird fauna of any island group in the world. The following brief look at their diversity and specialization amply bears this out. The 16 colonizers represented 11 distinct avian families or subfamilies, and the degree of change indicates the relative length of their tenure in the Hawaiian Islands:

ANATIDAE—a duck and two geese;
ACCIPITRIDAE—a hawk;
STRIGIDAE—an owl;
SYLVIINAE—an Old World warbler;
TURDINAE—a thrush (from the American solitaires?);
MUSCICAPINAE—an Old World flycatcher;
RALLIDAE—two kinds of rail, a coot, and a gallinule;
RECURVIROSTRIDAE—a stilt;
CORVIDAE—a crow;
MELIPHAGIDAE—an Australian honeyeater;
DREPANIDIDAE—a finch or honeycreeper, its origin and precise archetypic form unknown.

While each of these groups has its own fascination and helps us understand the workings of evolution, it is the Drepanididae which have excited the special interest of scientists around the world. This family's ancestor was probably the earliest avian arrival on the archipelago. In their wide divergence of form and behavior, its living members tell us of an extraordinary history.

Since the first discovery of the drepanidids in the late 1700's, their origin has puzzled biologists. Did they come from Australia, Asia, or perhaps Central America?—a knotty problem. For during their long association with the endemic Hawaiian forests, the drepanidids have responded to the peculiar environmental selective forces. Great changes in morphology and behavior have so altered the group that there are now species resembling finches, parrots, warblers and others, as well as honeycreepers. Recent studies have shed some light on the question of origin, but many shadows still remain.

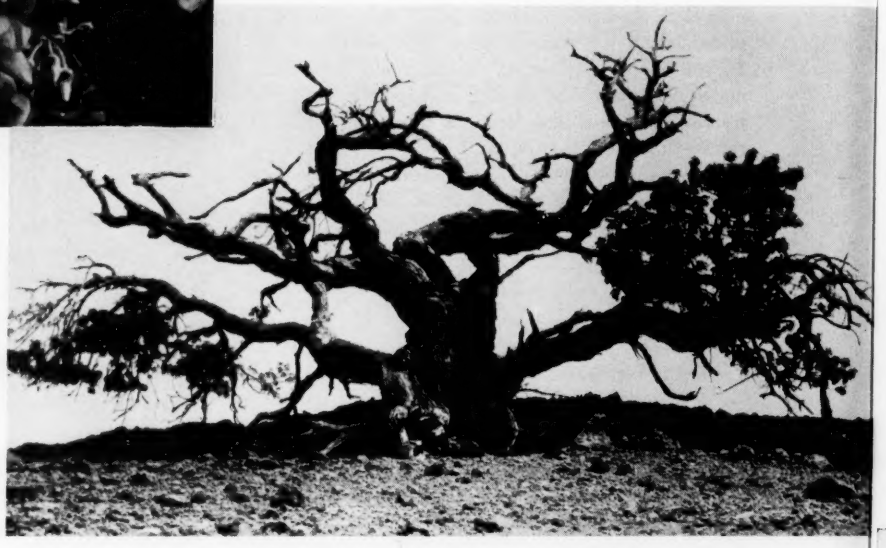
* Amadon, Zimmerman, Baldwin, and others have taken care of this subject very well in recent years.

Dr. Dean Amadon, after an exhaustive study of specimens in the American Museum of Natural History, tentatively concluded that the drepanidids had more affinities with the Coerebidae (a family of Central and South American honeycreepers) than with any other group. Dr. Charles Sibley of Cornell University, after studies of egg-white protein similarities, recently placed them with the cardueline finches. Whatever their origin, the drepanidids display such an astounding degree of adaptive radiation that they may be called a living museum of evolutionary processes. It was this phenomenon—the development of many divergent forms from a single ancestor—which so greatly leavened Darwin's thinking. He saw it at work in the Galápagos finches, *Geospiza*. If only Darwin had reached Hawaii, to see and recognize a far surpassing degree of the process in the Drepanididae!

The major impetus to drepanidid evolution was the

←(UPPER LEFT) The Hawaii Oo (*Acrulocercus nobilis*), a meliphagid or honeyeater, brown with bright yellow wing-patch. (LOWER RIGHT) The Ou *(Psittirostra psittacea)*, light olive with cream underparts, the male *(below)* with yellow head. ↓ (UPPER RIGHT) Kauai Akialoa *(Hemignathus procerus)*, light olive green, underparts yellow. The latter two species, drepanidids, show the extremes of bill adaptation in the family, evolved from a common ancestor. (From *The Birds of the Hawaiian Islands* by Scott B. Wilson, London: R. H. Porter, 1899; Wilson's excellent artist in Hawaii was F. W. Frohawk)

intermediates in all stages with accompanying behavioral adaptations for feeding on seeds, nectar, or the insects in forest trees and shrubs. There was even one subgenus *(Heterorhynchus)* that adopted the ways of the woodpecker, chipping off dead bark with its stout, straight lower mandible, then seizing the exposed insects. One species of *Heterorhynchus,* the



Birds go when their habitat dies: Dependent on the Mamane blossoms are the birds of its forests—the Iiwi, Apapane, and others in season. They must go elsewhere for food when the trees are stricken, when the feral sheep and other stock have completed their destruction *(opposite page).* When this has happened, such birds as the Palila and Nukupuu will become extinct through loss of their only habitat.

diversity of available foods there for the taking without competition from other species of birds. In combination with the plethora of food sources was the nearness to each other of Hawaii's main islands—geography's contribution to the splendid display of adaptive radiation this one family shows us today. A new type, evolving on a particular island, could on occasion be wind-blown to a neighboring one, there in a different environment to diverge still farther from its kin "back home" with whom it no longer interbred. Add to this a generous measure of geologic time, keep disruptive man out of the picture—and adaptive radiation is permitted a full degree of expression as a striking phenomenon, making Hawaii one of nature's great laboratories of evolution.

The result has been extraordinary—a few examples will justify our repeated superlatives: *Psittirostra kona,* the grosbeak finch, with its massive seed-cracking bill; *Pseudonestor xanthophrys,* its strong, deeply hooked bill resembling that of a small parrot; *Hemignathus procerus,* the Kauai Akialoa, whose bill was beautifully elongated and nicely decurved, perfectly adapted for plunging into the deep tubular flowers of the lobelia and searching for insects in cracks and crevices. Between these extremes of bill structure are Hawaii Nukupuu, still exists in small numbers high on the slopes of Mauna Kea. There it may occasionally be seen, working over the limbs of the Mamane trees. With stout, hammer-like strokes it chips away flakes of bark, prying and chopping with the lower mandible. The long, delicately decurved upper mandible is all the while held carefully out of the way. Then when a crevice is exposed the upper mandible probes in, to sweep out any insects or other small arthropods which may be hiding in the darkness.

Thus it was that diverse processes of evolution, acting on the few "experimental forms" so casually delivered to Hawaii's doorstep, expressed themselves in the course of geologic time. The same forces worked not only upon the avifauna, of course, but likewise upon the insects, snails, and other forms which by chance also reached the islands. Elwood Zimmerman in his excellent introductory volume to *Insects of Hawaii,* has concluded that from an ancestral stock of between 233 and 254 colonizing species of insects, there have since evolved 3,722 known endemic insect species. This is a truly incredible array of evolutionary products. So complete has been this evolutionary metamorphosis of the immigrants that, before the coming of the white man, Zimmerman estimates, 99 per cent

of the entire Hawaiian native insect fauna was found nowhere else in the world.

THE FOREGOING has suggested the biotic state of an isolated mid-Pacific island chain up to 18 January 1778, the day on which Captain James Cook quite accidentally made European man's discovery of a well populated archipelago and named it for the Earl of Sandwich.

It should not be surprising that the scourge of the white man's coming was felt not only by the native people—syphilis, measles, and other European "distempers" were among the gifts of *Resolution* and *Discovery*—but by other forms of Hawaiian life as well. Centuries of isolation from the myriad pathogens and pestilences of the "civilized" world had rendered the Polynesian biota—plants and animals alike—highly susceptible to the devastating effects of exotic diseases, insects, and practices. Here longest, and the most finely adjusted to their adopted habitat of all bird immigrants, the Drepanididae were naturally the most sensitive to the alteration, contamination, and gradual degradation of the Hawaiian environment.

There is something incredibly naïve about the response of Europeans (and Americans) to the realization that they might be doing more harm than good in their random, knockabout programs of exploration and colonization. They are often amazed, sometimes chagrined, that they could have such ill effects upon native populations. Nevertheless they—we—have persisted. Now, with Hawaii's natural history still another chapter in the annals of exploitation, it is in frustration, sometimes in despair, that we try to piece together the historical segment of the native biota's response to "discovery." With few exceptions, it is a story of disease and death, a chronicle of extinction.

When Captain Cook first examined the islands he wrote with excitement of the many beautiful red birds flitting about the trees and shrubs of the seashore. He was taken by the lushness of the green forests. He described an abundant and varied bird fauna, a country unspoiled and beautiful. Equally enthusiastic were the very early naturalists—botanists and ornithologists for the most part—that roamed over Hawaii's mountains and through its forests in search of native plant and bird species. Their accounts relate vividly the abundance of native birds in lowland areas, as well as the great beauty, richness, and variety of the undisturbed habitats. One young botanist in 1823 gave a lively description of the great quantities of birds flitting about the flowered canopies of native trees at the very edge of Honolulu.

In only a very few years virtually all lowland species of native birds had vanished abruptly and completely. Part of this displacement was due to extensive forest clearing for sugar cane fields and to sandalwood logging. Large areas of coastal forests were hewn down and undergrowth burned away for various kinds of agriculture. Native species dependent on these forests were swept away with them, and rapidly.

Of equal or greater impact were the progeny of the cattle, goats, sheep, and horses brought to the islands by Cook, Vancouver, and the early colonists who followed their wake. Allowed to multiply far beyond the needs of the settlers and calling ships,

Taken on Mauna Kea, Hawaii, these pictures represent vast areas of Mamane and other forest destruction in the Islands because of the early and continuing introduction of various domestic and game animals. (*See* Warner: "A Forest Dies on Mauna Kea," *PD*, March-April 1960.)

vast herds of livestock, turned feral, roamed over the mountains of all the islands. Enormous changes in the vegetation cover followed the overgrazing and trampling. Trees were stripped of leaves and bark, their plant understories eaten to the ground. Whole forests were thus destroyed, leaving behind bare, eroding slopes. Indeed, portions of Oahu and Lanai were completely denuded of their vegetation at one time. Kahoolawe was so devastated by goats and sheep that it is now a barren red desert, on windy days its remaining soil blowing out to sea in a great reddish cloud. So early was the destruction of Kahoolawe's forest by the introduced herbivores that we have no record of the animal or plant life that once covered its surface. There are still sheep on Kahoolawe, and

Overbrowsing, overgrazing, sharp hooves —it doesn't take long for trees, shrubs, grasses, and topsoil to go; and with the living land goes every living thing dependent on its bounty. (Mauna Kea is the site of this ruin.)

though during periods of summer drought they die by the score, a sufficient number maintain themselves to continue the suppression of plant growth. It is a classic case of an induced biological desert. But Hawaii boasts more than one such instance.

Laysan, a small leeward island of the Hawaiian Archipelago, experienced much the same history as Kahoolawe, although its destruction was much more rapid, precise, and complete. Lying some 900 miles WNW of Honolulu, Laysan Island at one time boasted a most peculiar and extraordinary biota. Together with a large number of endemic plant and insect species, this two-square-mile islet hosted no less than five endemic bird species—a duck, a flightless rail, an Old World warbler, and two species of Drepanididae.

Around 1900, rabbits were introduced onto the island as a food source for the few inhabitants and to provide the breeding stock for a canned rabbit industry. Within a few years the rabbits had mushroomed to enormous numbers, and in the process completely stripped the island of its vegetation. Three of the endemic bird species very quickly became extinct; the rail, the warbler, and one of the drepanidids just could not tolerate the vast changes of habitat. The duck and the remaining drepanidid clung tenaciously to existence, and while coming perilously close to extinction—the entire duck population at one time numbering six birds—they have managed to survive the ordeal. Fortunately in 1923 the last of Laysan's rabbits were exterminated by a party sent to the island for that particular purpose. With the partial recovery of the island's flora, the duck and remaining drepanidid finch are again increasing in numbers.

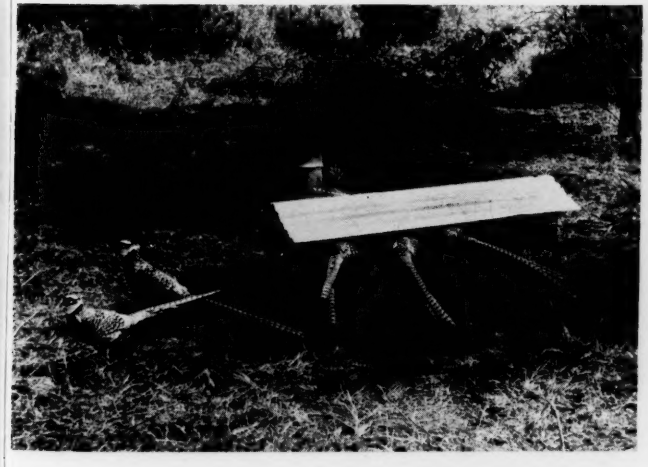
And so it was that over all of the islands feral and domestic herbivores were taking their toll of the native biota. Niihau, seventh largest island in the archipelago, no longer has any native flora after a century and a half of extensive sheep and goat raising. Oahu has but the most threadbare remnant of native forest, the remainder having been converted to agriculture or replaced, after denudation, by numerous exotic plant species, which provide no sustenance for the native fauna. Only on the top of Mt. Kaala, Oahu's highest mountain, does one find something approaching the native state. The rest, while containing koa *(Acacia koa)* and ohia *(Metrosideros polymorpha)* trees and a few of the more cosmopolitan native bird species, has been so contaminated by introduced plants such as the lantana *(Lantana camara)* and guava *(Psidium guajava)* as to be no longer "native" in any real way.

Recent evidence indicates the drepanidids faced still another destroyer—disease, borne silently on mosquito wings. It came with the domestic fowl of the explorers and early colonists, perhaps with the Asiatic and American birds that were brought in and liberated, or which escaped from their cages. It came as deadly virus diseases, as blood parasites which sapped the vitality of the highly susceptible endemics. It is of great significance, then, to discover in the literature of 1903 the following paragraph by R. C. L. Perkins, one of Hawaii's best known early biologists: "Like many other Drepanididae the species of *Hemignathus* are grievously affected by a disease, which is probably contagious, and causes swellings on the legs and feet, as well as on the head at the base of the bill, and on the skin around the eyes. One individual of *H. procerus* affected in all parts I picked up on the ground, it being quite unable to fly. Quite recently (Feb. 1902) two individuals of *Oreomyza flammea*

This is the foot of a drepanidid hit by the bird pox virus.

were examined, one of which was crouched on the ground at the foot of a bush, the other in the middle of a dense shrub. Both of these birds were affected on the head, and neither would move until they were actually poked up."

It was, as Perkins had guessed, an introduced bird pox virus. But to be really effective as an agent of avian genocide, bird pox needed a transmitting agent, a vector. We do not have to look far to find an ideal one—the mosquito. For along with his syphilis and typhoid, the white man had presented the Hawaiians with several species of mosquitoes. The first arrived in the water casks of the ship *Wellington*, which took on water at Lahaina, Maui, in 1826. With the pox virus and avian malaria pathogens available for transmission, a susceptible host awaiting infections, and a vector introduced to provide the leg work, disease swept inexorably through the native bird populations.



Recent studies by the writer have clearly demonstrated the extreme sensitivity of the Drepanididae to both bird pox and avian malaria. Either one will kill them within several weeks of exposure, malaria more quickly and with a mortality rate of 100 per cent.

It is therefore of more than passing consequence that those populations of drepanidids still to be found are largely, if not entirely, above the altitudinal range of the nightflying mosquito, *Culex quinquefasciatus*, known as the carrier of avian malaria.

In very recent years still another spearpoint has been added to the gauntlet the surviving endemics must run. Exotic game birds, imported in large quantities and with only a minimal quarantine period, are released en masse into upland areas. In the last year

alone, 1,969 exotic game birds of seven different species were released into the wild. Our knowledge of the diseases, especially the viral diseases, of game birds is still most fragmentary. In many cases there is no convenient way of determining whether a game bird is diseased or not, for the pathogen may be in a resting or "occult" state and not demonstrable by standard techniques. Such a pathogen, once activated by physiologic stress or other factors, is capable of regaining its full virulence and triggering an epizoötic of major proportions.*

In addition to these "sleepers" are the known parasites and diseases which have been permitted entry

* Quisenberry and Wallace in a 1959 article entitled "Arthropod-borne Virus Encephalitis Potentials in Hawaii," discuss some of the problems of introduced viruses.

Reeves pheasants are being imported and released into the mountain country of Kauai. In a massive exotic bird introduction program underway in the Islands, shooting game is being provided for sportsmen at the expense of native Hawaiian birds. (Photographs by the author)

The three photographs on these two pages are intended to illustrate both the present article and the one which follows. The biota of an area is the total community of plants, animals, soil, water, and air; all are interdependent. When any one of these elements is disturbed, the whole community suffers change.

One thousand acres of jungle on Hawaii is bulldozed into tame orchard land to grow macadamia nuts as a market commodity.

via exotic game birds. Coccidiosis, gapeworm, and several other quite bizarre Asiatic parasites have been knowingly introduced into the wild by the releases of exotic game bird species. And while the exotic may have a considerable degree of resistance to these pathogens, there is scant possibility that the native bird species would be equally fortunate. One such pathogen capable of invading the climatic sanctuary which now forms the final retreat of the drepanidids, would no doubt herald their final and permanent extinction.

Thus we have some semblance of a picture of Hawaii's native forest birds, with a somewhat clearer focus on the Drepanididae. Although many of the lines and shadings are yet to be added, we can nonetheless sense the gradual, vast-stretching processes which over a thousand thousand years gave rise to the Drepanididae, to all of the marvelous assemblage of endemic forms comprising the native biota, and to the sudden smashing of this beautifully complex structure.

The cataclysmic collapse and extinction of whole populations and species bears a striking resemblance to the simultaneous degradation experienced by the Hawaiian people. Both began with the arrival of the Europeans. Both resulted from essentially similar causes.

The history of the Hawaiian people is today almost closed. As a racial entity they are nearly obliterated; their blood lines are adulterated, their strength and numbers wasted by the European diseases. And while the native bird fauna still clings tenaciously to existence in the high and remote portions of the islands, these last refuges are one by one being nibbled away.

The very habitats of the Hawaii Nukupuu and the Palila are being eaten out from under them by herds of feral sheep, maintained in the interests of sport hunting at higher population numbers than the environment can tolerate. These will probably be the next species to vanish from the scene. Domestic and feral livestock on the slopes of Mauna Loa and Hualalai are likewise gravely altering the character of the forest habitats there.

What effect the Columbian black-tailed deer, *(Odocoileus hemionus)* recently introduced onto Kauai, will have on the endemics remains to be seen. The world was elated over the rediscovery just this year, by Richardson and Bowles, of several native bird species which had been presumed extinct for many years. Extremely rare, these species were found in only the most remote, undisturbed portions of Kauai's high rain forests. Our elation may well turn to horror should those promoting the introduction of the black-tailed deer have guessed wrongly about the effects of this mainland herbivore on the native forest habitat.

Perhaps it is not blind wishing to hope that among those now proposing the commercial utilization of Hawaii's forests there is someone who sees the value and importance of the native biota. For this impending program of widespread removal of native forests and replanting with exotic trees for timber and other purposes will permanently and irretrievably change the character of the mountain environment.

Thus the history of Hawaii's native avifauna is still being written. Whether the next chapter is vibrant with the formation of state parks and natural areas for the preservation of the native biota, or contains instead the leaden words of the drepanidids' obituary, is uncertain. The decision, and it is a choice, lies largely with those in whose care these elements of Hawaiiana have been placed.

Let us hope that, despite the cries for more to kill, for more to cut and sell, or more to slaughter, there will be some intelligent concern for preservation.

If there is to be preservation it must come soon; the time for decision is running out.

What is the answer to the eternal question of man's economic interest versus the recognized need for preserving some samples—at the very least—of natural landscape with its wild life?

Hawaii—the rest of America and the world has a stake in this, too—must decide where to stop in converting wild land to economic uses. It will be gone, one day soon, before we know it. (Photographs courtesy of Castle and Cooke, Ltd.)

OTTO & ISA DEGENER

The native home of this graceful member of the large and world-encircling family of the palms—Palmaceae—is the Hawaiian Islands. It is *Pritchardia macrocarpa* and this is the type specimen from which the species was described in 1879. Usually a type specimen of a plant is something dried and kept carefully in an herbarium; a living one is exceptional. This thriving "specimen" is the proud possession of the Foster Botanical Garden courtesy of the Garden)

Floral Footnote: FOSTER BOTANICAL GARDEN

In 1855, Dr. William Hillebrand, German-born physician to Kamehameha V, began the fine collection of tropical plants now known as Foster Botanical Garden. Dr. Hillebrand is remembered for his *Flora of the Hawaiian Islands* and, locally, for his introduction of numerous ornamental species now naturalized throughout the State. The present Foster Botanical Garden was a bequest of Mary E. Foster in 1930; the garden is named in her honor. The Fosters purchased the garden from Hillebrand in 1880. The 17-acre planting is "headquarters" for a system comprising a total of 250 acres, newly acquired and largely undeveloped, located in four ecological areas of the Island of Oahu. The largest area, totalling 200 acres, is located within the extinct caldera of Koko Crater and is named in memory of Dr. H. L. Lyon, first director of the garden and through whose influence the garden was bequeathed to the people of Honolulu.

The collection is most noteworthy in respect to the species of endemic Pritchardias gathered here from all parts of Hawaii, including the type specimen of P. macro-

Green Hawaii PAST, PRESENT, AND FUTURE OF AN ISLAND FLORA

THE PAST, present, and future of the Hawaiian flora is not difficult to visualize. Limiting ourselves to the flowering plants, we find that except on a seashore fringe where such halophytes as a few *Ipomoea,* a *Plumbago,* a *Tribulus,* and a *Vitex* grow, and on a few mountain tops where a sundew *(Drosera)* and a sedge *(Carex)* flourish, the Islands' native flora consists wholly of endemic species, varieties, and forms; they evolved here.

Several factors have contributed to this rate of endemism—geographical position and time, to begin with. From Cape Kumukahi, the easternmost point of Hawaii, west-northwest to Kure or Ocean Island, the speck beyond Midway, our archipelago extends 1,800 miles across the surface of the Pacific (farther, at its base on the ocean floor); this same visible portion of the chain began to emerge as dry land in the Pliocene, perhaps 13,000,000 years ago. To it came relatively few propagules—seeds, roots, shoots, or any plant parts capable of propagating their kind—brought by winds, currents, or birds, to begin the island vegetation which has survived, more or less altered, to historic times. Endemism, meaning here the development of new plants in the islands out of such chance ancestral arrivals, was stimulated by isolation—not only of Hawaii from other lands but of one island from another in the lengthy chain—usually under extremely diverse edaphic (soil) and other conditions favorable to speciation. Furthermore—and at first glance this seems contradictory – new plants came into being through the closeness of one island to another in parts of the archipelago, which encouraged hybridization and incidentally, the creation of annectant, or intergrading, forms to confuse the plant taxonomist. As if the expected ecological diversities of an island group were not enough, Hawaii is peculiar in having provided veneers, as one eruption blanketed another, containing *kipuka,* or lava oases, continuously from earliest times. Such an "island" or oasis of older volcanic landscape cut off and surrounded by a new lava flow could remain uncovered, in turn, long enough to allow plant or animal forms surviving in isolation upon it to become differentiated significantly from those of separate land areas co-existent with it.

Because of their position and stepping-stone character the more ancient islands west of Kauai became clothed mainly with Old World species. Many of these, increasingly modified, got disseminated to the newer islands, from Kauai eastward to Hawaii, as these gradually arose from the ocean. The vegetation of the older western islands gradually died out as the elements eroded them to near ocean level.

Less than 2,000 years ago this infinitely slow process of natural evolution was disrupted when the Polynesian voyagers discovered the Hawaiian Islands and jolted the native vegetation out of its status quo by fires, cultivation of plants they brought with them for foods, fibers, and medicines, the escape of a few stowaway weeds at lower and middle elevations, and by their pigs and Polynesian rats even at higher elevations. As isolated valley mouths and plateaus are known (from personal observation) to harbor taxa—species, varieties, and forms—peculiar to them, their planting to exotics by the old Hawaiians may have reduced the native Hawaiian vegetation by nearly 500 peculiar kinds of plants.

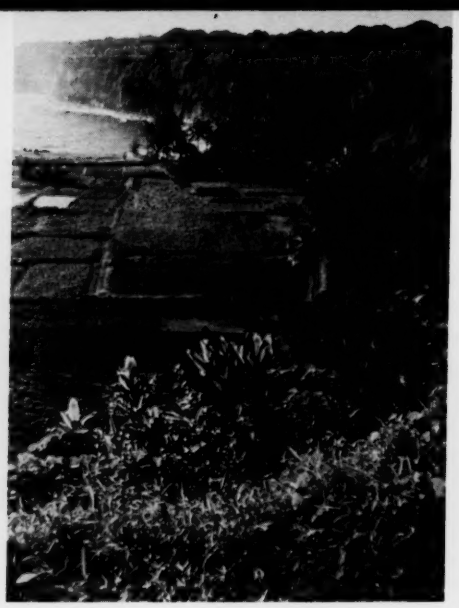
Extermination of the native flora proceeded at ever-increasing speed with Cook's 1778 introduction of goats; Vancouver's 1793 landing of cattle and sheep, the former running wild and increasing practically uncontrolled; Cleveland's 1803 introduction of horses; the Mikado's 1867 gift to Kamehameha V of axis deer; and our government's apparently reckless introduction during the last decade of a veritable Noah's Ark of pronghorn antelope, mouflon sheep, brush-tailed rock wallaby, Rocy Mountain mule deer, Columbian black-tailed deer, and what not—extermination has gone ahead in this period by leaps and bounds. A better team to rush the endemic flora to extinction would be difficult to make up!

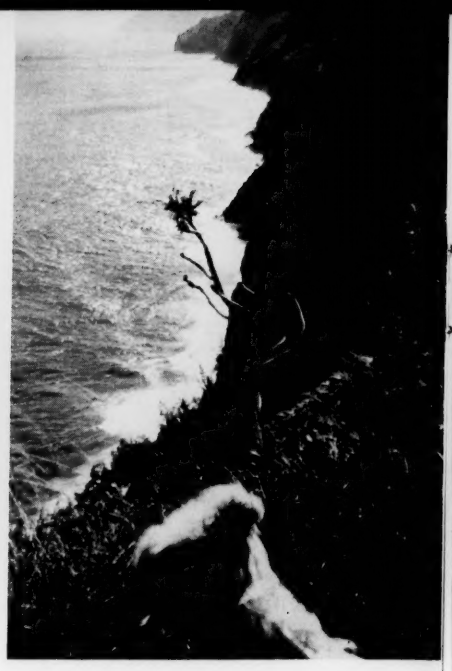
Modern man himself is outdoing his animals and earlier man. Besides the areas planted to cane, pineapple, macadamia, vegetables, exotic weeds and forest trees, huge tracts have been recently bulldozed

carpa collected and planted by Hillebrand. About 15 species of Hawaiian Pritchardias are now represented.

Foster Botanical Garden is currently preparing for some important capital improvements, working drawings of which are in progress. These improvements include, among other elements, a lecture hall for a projected public education project, a library and most important, a humidified "coolhouse" in which will be grown the unique endemic flora of the mountains of Hawaii. These plants, such as the shrubby and arborescent lobeliads, and composites, the lovely species of tree ferns, the interesting araliaceous trees and the local Gunneras, require cooler and moister conditions than prevail at coastal elevations. A special area, cold and dry, will be arranged to accommodate the spectacular "Silversword" *(Argyroxiphium sandwicense)* and the silvery geraniums of the highest slopes of 10,000-foot Haleakala Crater. The garden is fortunate to have Dr. Joseph F. Rock consulting on this project. Study and display of endemic flora will be a prime objective of the new Foster Botanical Garden.

PAUL R. WEISSICH





↑ Taro, a cultigen of the Hawaiians.

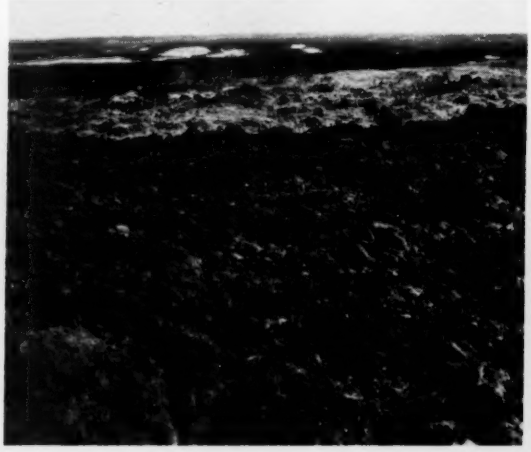
Kipuka from the inside—a famous one near Kilauea crater, Hawaii, in which are living some plants and birds found nowhere else. (See BELOW)

for housing and "dream cities." The result is that by 1960 of Kauai's 355,200 acres only 60 per cent remain available for native growth; of Oahu's 386,560 only 40 per cent; of Molokai's 167,085 only 28 per cent; of Lanai's 90,240 only 73 per cent; of Maui's 465,920 only 34 per cent; of Hawaii's 2,579,200 only 18 per cent; while of Kahoolawe's area practically nothing remains for vegetation as goats have eaten it so bare that its soil has blown away. The picture created by these percentages of land available for endemics must be corrected by certain allowances, however: an acre of flat land gives plants a surface foothold of 4,840 square yards; but an acre of precipitous Kauai tapestry forest, for instance, gives far more.

Such unused surfaces available for endemics would seem to be unspoiled by man, yet this is not so. Feral herbivores and exotic plants have swarmed into these refuges. To make matters worse, some of the nastiest plants have been scattered by government officials helter-skelter from planes, to reforest remotest areas that never required reforestation.

By comparing the number of taxa of certain genera listed by Hillebrand in his *Flora,* completed about 1871 but published posthumously in 1888, with recent monographic treatments of the same genera by Fosberg, Sherff, Skottsberg, Wimmer, and Yuncker, we find a fourfold increase in recognized species and varieties. Were we to assume that all of Hillebrand's genera, similarly monographed, would show a like increase, the taxa of endemic flowering plants for the Hawaiian Archipelago would total about 4,000. After we study relief maps showing our chopped-up terrain and visualize the very few knife-edges and streambeds, lava fields and precipitous mountains we, our colleagues, and our predecessors have traversed, and the vast areas still requiring extensive, and costly, exploration, we hazard an estimate of 30,000 surviving endemic taxa for the Hawaiian Islands, worthy of treatment in a *Flora* according to American and European standards—a modest one indeed. Please remember, no one believed Marco Polo (1254?–1324?) nor Galileo (1564–1642) either.

Black lava of a more recent flow—foreground and far distance—surrounds a kipuka seen in middle distance. Towards the far horizon kipukas appear as small light patches on the dark ground of newer lava.



↓ Kauai silversword (*Wilkesia*) seedlings spring up in the wake of the bulldozer.

← An acre of precipitous mountain harbors more plants than an acre of flat land.

↓ Molasses grass and other exotics are sown by plane, hit or miss, crowding out endemics.

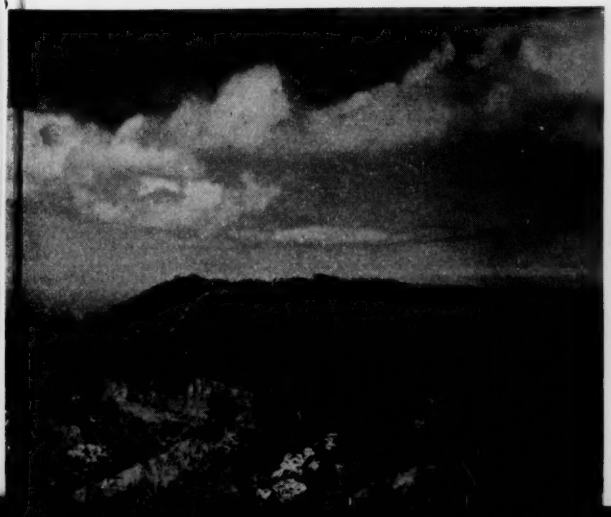
↓ A hundred acres of forest bulldozed in 1961 for planting pines and monkey pods. (See also p. 12)

← The Napali Coast is being stocked to mouflon and other herbivores.

Nevertheless, the future of Hawaii's native flora is hopeless, we fear. Ordinarily our lava flows and our cloud belts devoid of sufficient sunshine for crop plants should permit our endemics to survive in peace. But ordinary man, being an avaricious animal, twists the word "conservation" to mean that our natural resources should produce something of lucrative rather than scientific value. This is his challenge. Hence he won't rest until he has found some exotic lumber tree that will replace our native forests, and some exotic game animal that will browse on native vegetation in areas not suitable for lumbering. Tourists of the future may as well skip Hawaii Nei, if this goes to its logical end, for it will have lost its peculiar charm.

Our advice is to follow your writers' lead—one of us began in 1922 to salvage as much as possible of the fast vanishing Hawaiian flora at least in the form of herbarium specimens. Future generations can then marvel how quickly and efficiently their forebears exterminated a magnificent flora that took Nature millions of years to create.

↓ Faulty reforestation, promoting erosion, was practiced this year on the dry side of Oahu, with draglines clearing endemics up and down slopes.

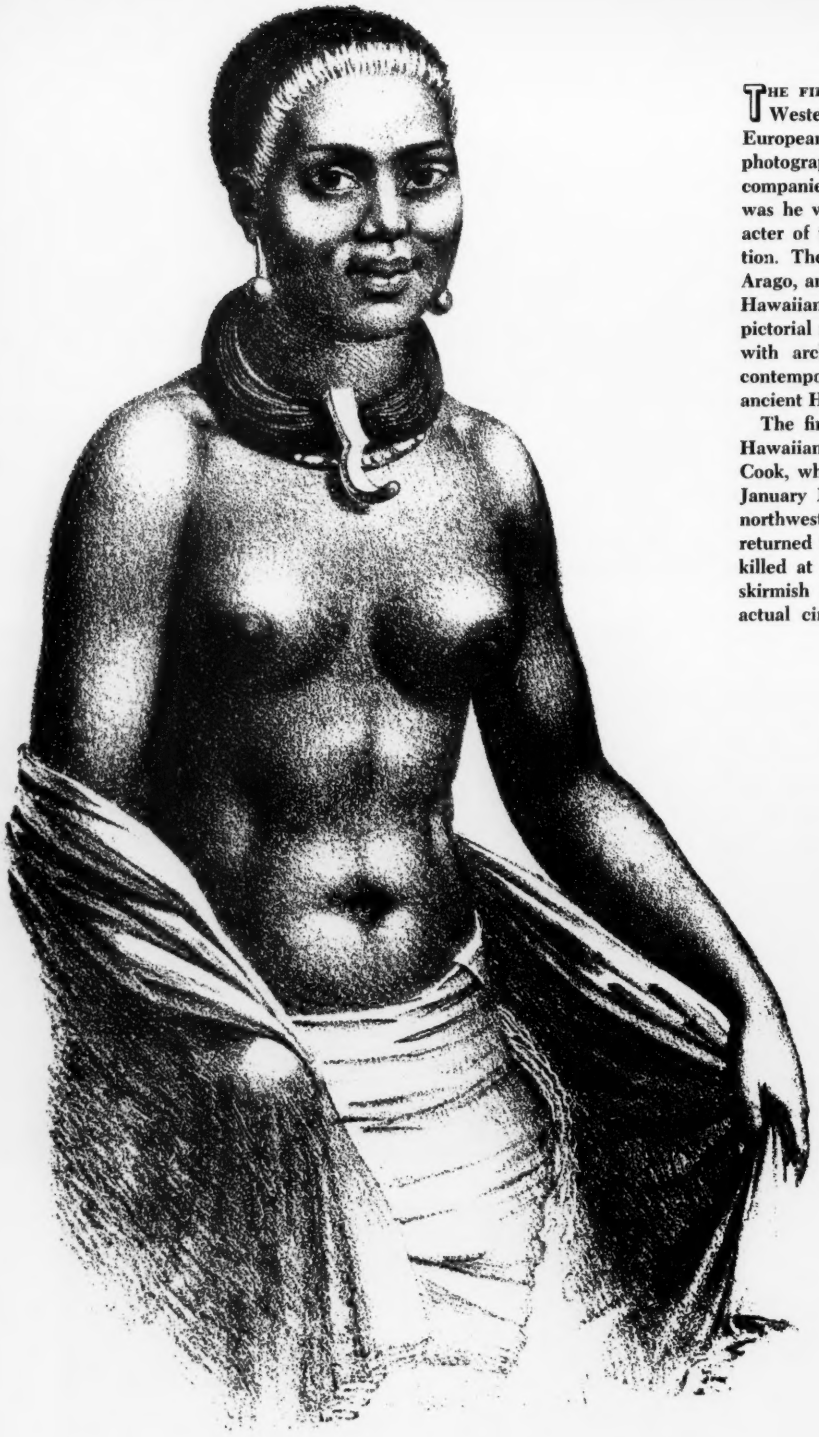


↑ The introduced blackberry, *Rubus penetrans*, crowds other plants and man from vast areas of upland Kauai.

ALEXANDER SPOEHR

THE FIRST KNOWLEDGE OF HAWAII was brought to the Western World through the 18th and 19th century European voyages of exploration into the Pacific. With photography unknown in those days, the artist who accompanied each voyage played an important role, for it was he who documented visually the customs and character of the island peoples encountered by each expedition. The sketches of artists such as Webber, Choris, Arago, and Heddington are an invaluable record of early Hawaiian life. Today, the information contained in the pictorial record they left for posterity can be coördinated with archeological evidence, museum collections, and contemporary written accounts to provide the outlines of ancient Hawaiian culture.

The first documented European voyage to reach the Hawaiian Islands was the third voyage of Captain James Cook, who landed at Waimea on the island of Kauai in January 1778. Thereafter, Cook departed to explore the northwest coast of North America and Bering Strait. He returned to the Hawaiian Islands in November, and was killed at Kealakekua Bay on the island of Hawaii in a skirmish with Hawaiians on February 14, 1779. The actual circumstances surrounding his death have been



A noble Hawaiian lady of earlier times wearing a necklace signifying chiefly rank, of braided human hair with ivory pendant. A fringe of her own hair is bleached, her skirt is tapa. (After Choris)

➔ (ABOVE) Hawaiian village at Waimea, Kauai, with thatched houses. The figures include both native Hawaiians and members of Captain Cook's party. (Drawn by Webber, an artist on Cook's third voyage)
➔ (BELOW) Hawaiian canoes coming out to meet Cook's ships at Kealakekua Bay, island of Hawaii, where Cook was later killed. (After Webber)

A Millennium of Hawaiian Discovery

much debated and are still not clear, but were probably due as much to misunderstanding between Hawaiians and English as to aggression on either side.

At the time of Cook's visit, there were some 300,000 Hawaiians in the islands. They lived as fishermen and farmers, raising taro, bananas, yams, breadfruit, sweet potatoes, sugar cane, and other domestic plants. The Hawaiians resided in dispersed villages. An elaborate system of temples and priesthood existed, and society was rigidly stratified into nobility and commoners. Warfare was common, for Kamehameha I had not yet consolidated the islands into a single state.

Following Cook other explorers visited Hawaii. Noteworthy among these were Vancouver (1792–94), Lisiansky (1804), von Kotzebue (1816–17), Freycinet (1819), and Byron (1825). Sketches by some of the artists who accompanied them are shown on these pages.

Temple drums.

Large wooden image from Kauai.

KENNETH P. EMORY

BY THE TIME EUROPEANS had discovered the Hawaiian Islands, lying so remotely in the Pacific, the Hawaiians themselves had been isolated such a length of centuries that they had only a vague idea of lands over the horizon. They could not name any among their ancestors who had discovered the islands or led the first settlers. They did, however, recite genealogies going back to various ancestors who in their traditions sailed the ocean from "Kahiki" to reach Hawaii. The longest of these counts is 36 generations. This would take us back to A.D. 1050, allowing 25 years to a generation. The shortest genealogy numbers 25 generations, and, using the same scale, would take us to A.D. 1325.

In the mid-nineteenth century a "tradition" was invented, and a chiefly genealogy altered to go with it, which had a man named Hawaii-loa, 64 generations ago, discover and settle the islands, naming the largest after himself and the others after his children. The Hawaiian scholar, David Malo, writing a generation earlier, had only said that "possibly the names of the first men to

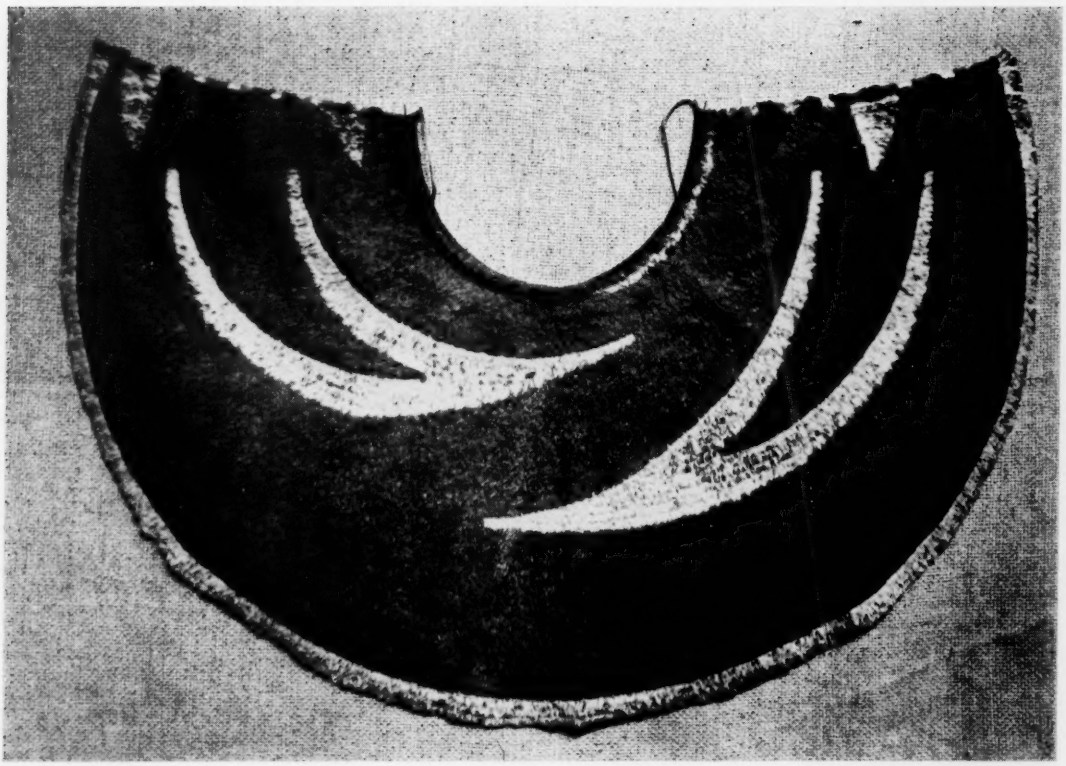
Hawaiian temple, showing the massive, upright wooden images. (After Choris, artist of the Russian scientific expedition in the *Rurick*, commanded by Lieutenant Otto von Kotzebue, which visited Hawaii in 1816 and 1817 during a three-year voyage in the Pacific)

settle on these shores were Hawaii, Maui, Oahu, Kauai, and that at their deaths the islands were called by their names." The Hawaii-loa legend has the first man molded in the image of the god Kane, and from his shadow the first woman was created. Present also is the expulsion from a garden as a result of eating a mountain-apple, a flood, and finally a story that makes it clear to us the author had in mind that the Hawaiians were descended from one of the lost tribes of Israel, and migrated eastward guided by the morning star to Hawaii. This oft-quoted "tradition" is responsible for the belief that there was a first migration directly eastward from Micronesia to Hawaii, nearly 2,000 miles distant.

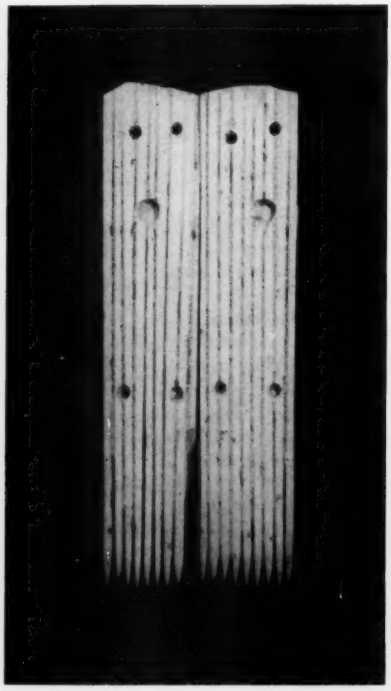
Beginning in 1950, the Bishop Museum in coöperation with the University of Hawaii set out in earnest to discover, through the employment of modern archeological techniques, what could be learned concerning the first settlers, when they came, and where they came from. Digging down through sites which had every indication of being continually occupied from the time of man's first appearance in the vicinity, it was found that these early people had stone and bone implements such as occur in Tahiti and the adjacent Marquesas Islands, but which are not found in western Polynesia or in Micronesia. Radiocarbon datings indicate that they were well established in the islands at least by A.D. 950, and possibly several centuries earlier. The presence of dog or pig bones and rat teeth-marks on these bones in the earliest sites has caused us to revise our belief that prior to the coming of these chiefs from "Kahiki" the islands had been settled by castaways who were commoners. Only a chief could have built an ocean-voyaging canoe and mounted an expedition carrying himself, his people and their women, and these animals over the more than 2,000 miles which separated the Hawaiian Islands from the rest of inhabited Polynesia.

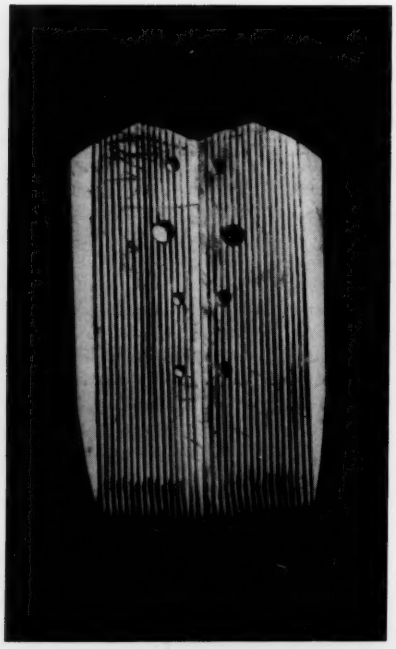
Excavation begun in the Marquesas Islands in 1956 by the American Museum of Natural History, and in the Islands of Tahiti in 1960 by the Bishop Museum and the American Museum of Natural History, combined with further investigation in the Hawaiian Islands, will eventually disclose the part played by these early inhabitants to the south in establishing in the Hawaiian Islands a flourishing branch of the Polynesian people.

➔ More photographs, next two pages ➔



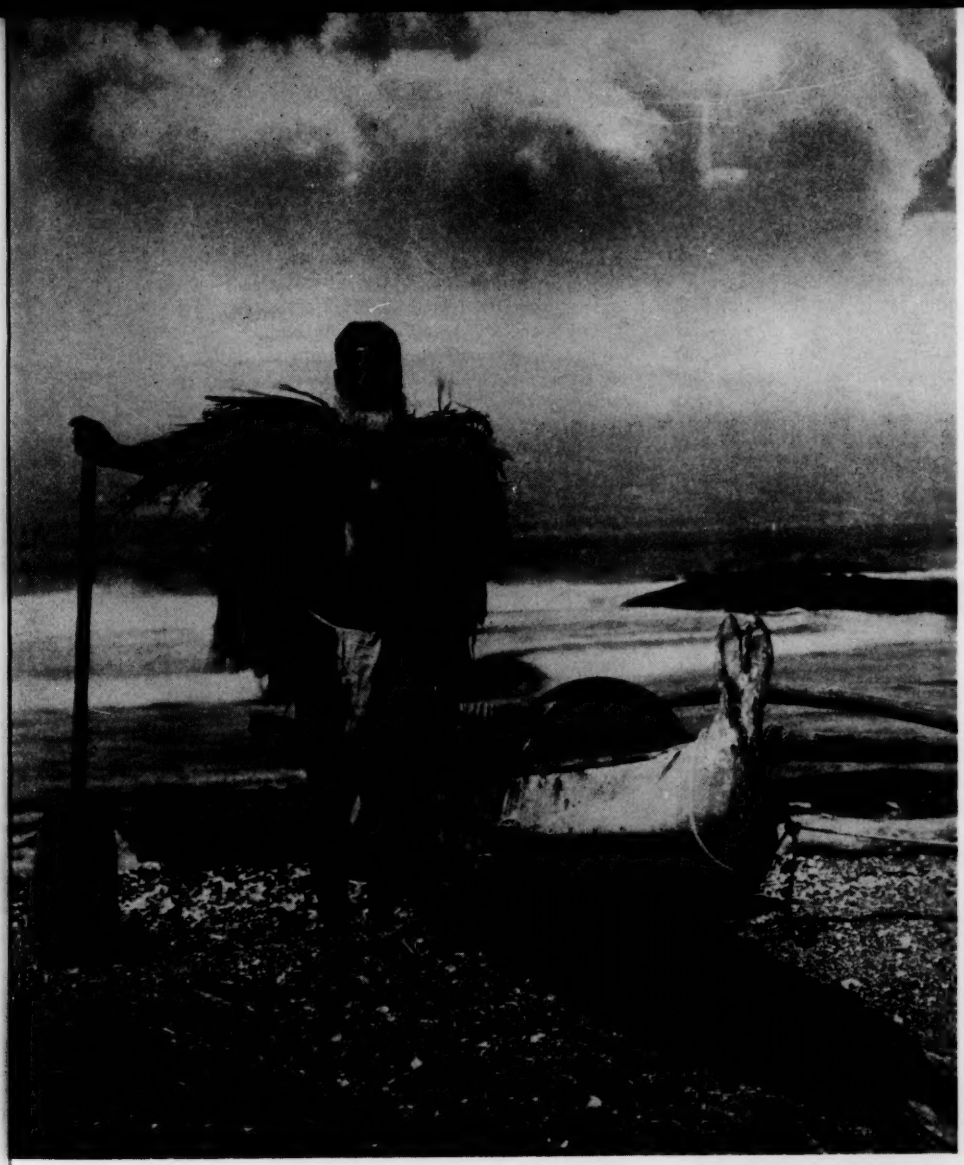
One of the priceless Hawaiian feather capes in the Bishop Museum collection. The red, gold, and black feathers used in cloaks and capes were supplied principally by four species of native birds: *Vestiaria coccinea*, *Himatione sanguinea*, *Moho nobilis*, and *Drepanis pacifica*. For royal wear, each garment used thousands of feathers.





(All photographs by courtesy of Bernice P. Bishop Museum)

Ancient Hawaiian tattoo needles, found in Bishop Museum diggings. This is the type used in the tattooing of Arago's chief shown on the cover.



Hawaiian fisherman on the shores of Hilo Bay, island of Hawaii. This old photograph in Bishop Museum files is distinguished for its authentic portrayal of the Hawaiian past. The fisherman is wearing a typical raincloak of ti (*Cordyline terminalis*, see also page 31) leaves, breech-clout, sandals. His canoe is a single outrigger, dugout hull with added plank sheer strakes (see *PD*, May-June 1959, pp. 8–9, for detailed description and photographs of canoe construction with laced planking).

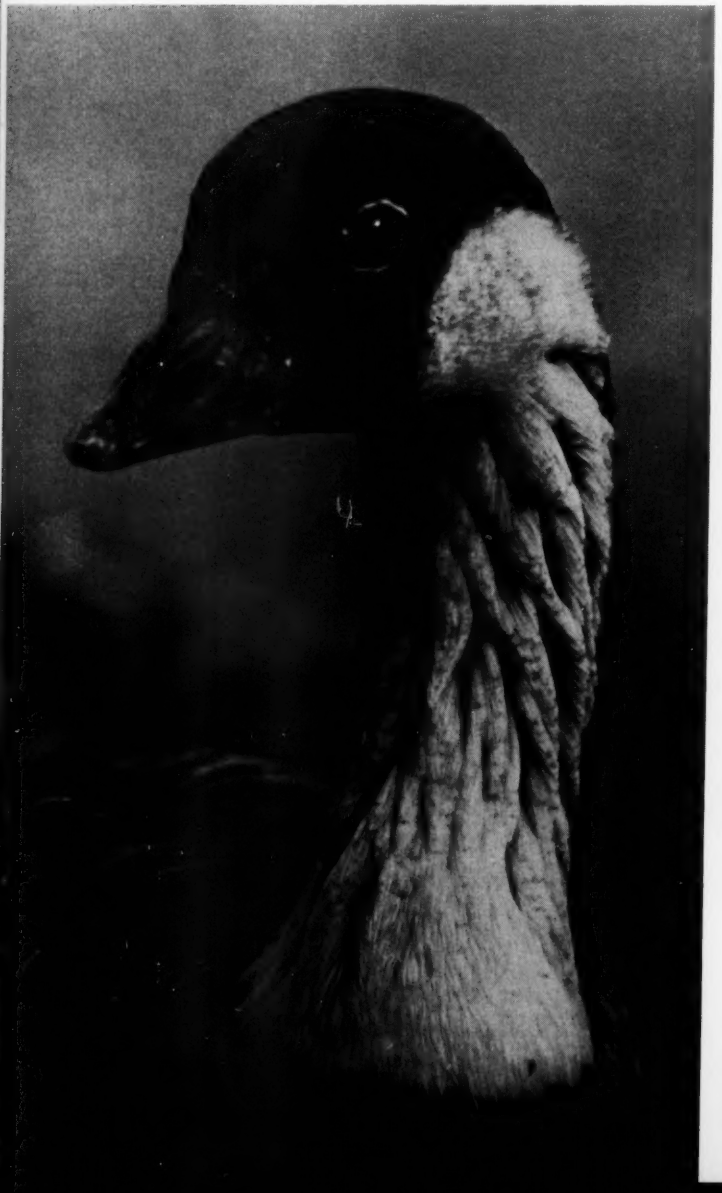
Digging into Hawaii's past, a Bishop Museum field team excavates an ancient village site at South Point, Hawaii. This site has yielded the earliest evidence of man's occupation of the Islands, well over a thousand years ago. Archeological investigation of Hawaii is carried on under the personal supervision of Museum anthropologists and archeologists.

Decorated gourd, used as a food container.

THE PRESENT EFFORT *to save the native Hawaiian Goose or Nene, as it is known in Hawaii, from extinction in its native habitat was started twelve years ago by the Territorial Board of Agriculture and Forestry. At that time there were only thirteen Nene in captivity in the entire world and estimates of the remaining wild population ran from twelve to less than fifty birds! The program was designed as a three-phase project. First, captive Nene were to be acquired and raised under wire until a substantial breeding flock was reached, from which there would be annual releases to augment the few remaining wild birds. Second, ecological studies were to be made of the wild Nene population and its habitat to determine what factors might be adversely affecting it. The third phase was to be the acquisition and management of sanctuary areas so as to increase the chances of survival of the remaining wild Nene and of those released.*

Initially this program was financed by a $6,000 appropriation of the 1949 Legislature of the Territory of Hawaii. This sum was to last for two years and to cover only the first or propagation phase of the project. The Territorial Government provided no other funds and it was necessary to postpone the second phase. It is to the credit of Mr. J. R. Woodworth of the Division of Fish and Game that the project was able to survive for almost nine years on a two-year budget!

However, as a result of progress made in rearing captive Nene, and information gathered on the existing wild birds, a Bill was introduced in Congress to authorize the U.S. Fish and Wildlife Service to engage in a Nene Restoration Program and to spend a total of $75,000 in five years. Strongly endorsed by conservation organizations and agencies, this Bill was passed by the 85th Congress as Act 891. With funds available the Fish and Wildlife Service immediately assumed responsibility for the existing Hawaii State Project by engaging in a contract with the State. On the basis of this contract two men were assigned full-time to the project.



Nene

ON AUGUST 1949 Mr. Herbert Shipman of Hilo, Hawaii, loaned the Government a pair of breeding Nene from the only captive flock then in existence of Hawaii's future "State Bird." These were taken to Pohakuloa, a Forestry and Fish and Game camp 6,500 feet up in the interior of the Island of Hawaii. They were placed in a large, specially constructed pen, provided with a pond, and given the best of care. The first year this pair produced two fine goslings. This original breeding stock has since been augmented by the capture of four wild Nene and a gosling which was hatched from an egg salvaged from a deserted wild nest.

Many men familiar with the problems of raising wild species of waterfowl in captivity have contributed generously to the project their time and experience. Mr. John Yealand of The London Zoo, formerly Curator of Birds, Severn Wildfowl Trust, spent several months at Pohakuloa during the first year. Mr. Paul Breese, Director of the Honolulu Zoo, has served as Chairman of the Nene Advisory Committee and has been most helpful in researching new techniques and developments in waterfowl care. Mr. Wesley Batterson of the Oregon State Game Commission spent three months at the Pohakuloa project during the 1960–61 breeding season. He introduced several new innovations and procedures which he had used successfully in raising various forms of geese. Other prominent

DAVID H. WOODSIDE

Nene. (Photo by Charles W. Schwartz, Jefferson City, Missouri)

Male adult Nene at Pohakuloa rearing project.

authorities on waterfowl who have visited the project and have contributed helpful suggestions and information are: Dr. Jean Delacour, Dr. Dillon Ripley, Peter Scott, K. C. Lint, S. T. Johnstone, William J. Sheffler, and William H. Phelps. Dr. William Elder devoted much time to the rearing project and contributed numerous recommendations after careful analysis of the various problems involved.

Although the project was plagued by a very low fertility rate and considerable embryo mortality, young Nene were raised each year and facilities have been enlarged till at present there is over one-half acre under wire. Production reached an all-time high when 32 young birds were raised this past season. It is planned to maintain a breeding flock of approximately 16 pairs and to gradually replace older, less productive birds with new stock of wild ancestry. There are indications that fertility in the wild strain of Nene is considerably higher than the strain which has been in captivity for some 40 years.

The ecological survey phase of the program was most seriously hampered by a lack of funds for adequate field work, but some progress was made in the early years of the project. By 1956, it was determined that there were at least 28 wild Nene on Hawaii. Their summer habits were studied and the summer range was defined.

During 1957–58 Dr. William Elder of the University of Misouri, one of America's foremost waterfowl authorities, conducted a year-long ecological study of the wild Nene financed by private funds. Much important information was gathered and the long-sought breeding ground of the wild Nene was discovered in Keauhou, adjacent to Hawaii National Park on Mauna Loa. Wild Nene were banded and their movements traced, identifying the birds on the known summer range as those on the nesting grounds.

Since the start of full-time field work in 1958, much more information has been gathered on nesting success of wild Nene and Nene survival and movements on Hawaii.

The first annual release of pen-reared Nene was made in March 1960 when 20 young birds from Pohakuloa were placed in a one-acre enclosure on the Keauhou nesting grounds of the wild birds. They remained in the pen for one month while their flight feathers were growing after the annual moult. For another three weeks they returned to the pen for feed and water but soon learned to exist entirely on native feeds. This first release was considered a success as 19 of the birds remained in the vicinity of the release pen all summer long. They were seen in company with wild Nene but did not follow them to the summer range. During the breeding season three of these young birds were seen paired with wild birds.

During April 1961 eleven more young Pohakuloa-reared birds were placed in the same release pen, making a total of 31 Nene released in the area. It is not planned to release more pen-reared birds in the Keauhou area until the results of the first two releases can be appraised. Instead, releases will be made in other areas known to be used by wild Nene or which contain suitable nesting habitat.

Twenty Nene ready for release in the Keauhou Sanctuary. They are one, two, and three years old. (Hawaii F&G)

With the major breeding ground of the wild Nene discovered, steps were taken to assure its protection. A ten-year agreement covering 8,100 acres was made with the owners and lessees restricting changes in the area and permitting project personnel to control predators, such as mongooses, pigs, cats, and dogs by any means, and to post and patrol the area against tres-

pass. With adjacent Hawaii National Park and surrounding State Forest Reserves, this makes a very large area for Nene to nest and feed in. The Department of Agriculture and Conservation has declared it a Sanctuary and now covers it by protective regulation.

Management of the area to date has consisted of predator control by placing poison-impregnated meat baits in the areas of Nene concentration, control of feral goats which tend to attract poachers and dogs, and the construction of a small field shack used by project personnel while caring for Nene in the release pen or on other field work.

Besides the Keauhou Nesting Sanctuary, the entire portion of the summer range which is State-owned, some 32,000 acres, is closed to hunting during the summer months. Predator control is not feasible in this vast area.

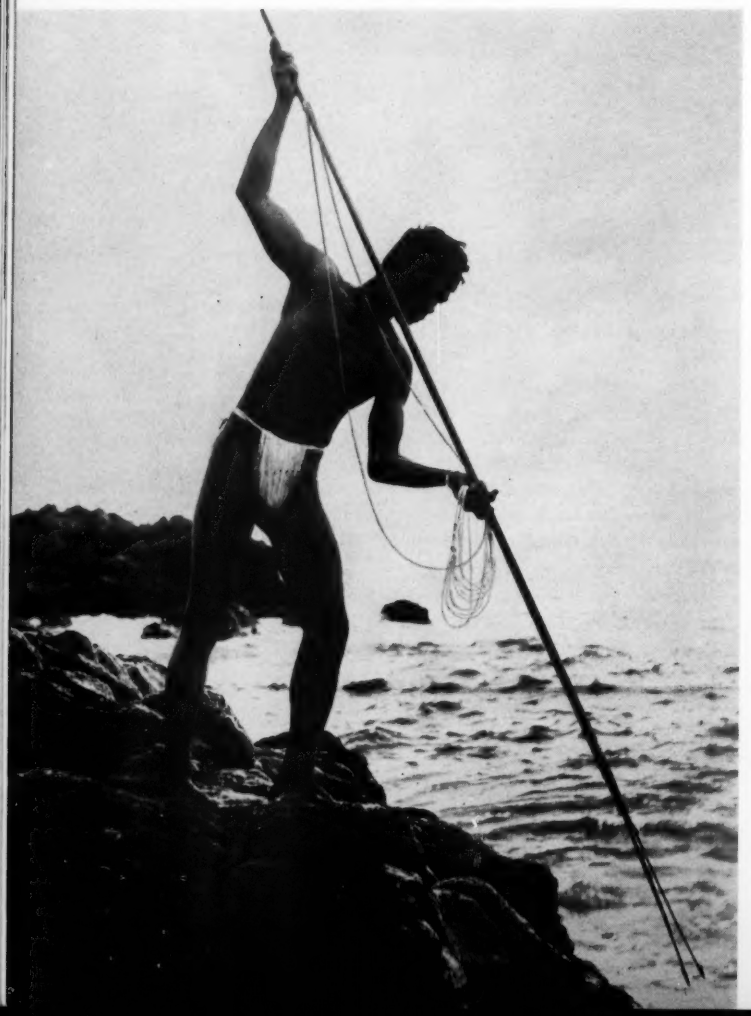
Negotiations are in progress to acquire some degree of control over an additional block of Nene habitat, some 20,000 acres which still has a remnant Nene population. The area is ancestral Nene breeding ground about 30 miles from that of the Keauhou. We hope to restock the area with pen-reared birds, control predators which are numerous, and restrict any further changes which may be detrimental to Nene.

IN THE PAST 12 YEARS, *the Nene, as a wild species in its native habitat, has received a new lease on life. Through the combined efforts of individual conservationists, private conservation organizations, the State and Federal Governments, and private land-holders, a program has been formed which appears to have every chance of success in restoring this unique member of Hawaii's fauna.*

Much remains to be done. Many more Nene must be raised and released, much has yet to be learned concerning the life history of wild Nene and factors affecting the population, and more areas will have to be maintained as sanctuaries and more permanent control acquired over these areas.

In the present session of Congress a Bill is pending which would increase the annual expenditure by the Fish and Wildlife Service to $25,000 and which would extend the project another five years. This would allow some enlargement of the rearing project phase, more man-power for field surveys, and better predator control in the sanctuary areas.

Since the inception of the current project the people of Hawaii have shown increasing awareness of and interest in the Nene. In 1958 the Legislature declared the Nene to be the official bird of Hawaii, and through all news media the public is kept informed of its progress toward a certain future.



Science C

KNOWLEDGE of Hawaiian fishes has advanced greatly since that notable day in January 1778 when Captain Cook first set foot on the Islands. Although ethnologists believe the ancient Hawaiians knew a great deal about the local fishes, much of that early lore seems to have been lost through the years, and so today ichthyologists are in the process of recovering this information. The first widescale investigations of the Hawaiian fishes began in 1901 under the auspices of the U.S. Fish Commission with David Starr Jordan as project leader. Reports of these investigations, in which the research vessel *Albatross* played an important part, were made by Jordan and his colleagues, Evermann, Gilbert, Snyder, and others. These careful reports still form the basis of much of the modern work being carried out today. In fact, the report on the deep-sea fishes by Gilbert is still the only work of its kind for the region.

In 1928 the Bishop Museum published Henry Fowler's *Fishes of Oceania* which, with its three supplements, was an attempt to bridge the gap from the earlier investigations to the present and also to relate

Hawaiian spearfishing in the old way.
(Photo courtesy Bishop Museum)

The hard-working *Salpa*, one of the research vessels of the University of Hawaii's Coconut Island Marine Station. (Camera Hawaii)

e Goes Fishing

EARL S. HERALD

the Hawaiian fauna to the other fishes of the Indo-Pacific region.

During the war years there was a tremendous demand for a fish identification handbook of the Hawaiian species for use by the members of the armed forces. To meet this need, Spencer Tinker, Director of the popular Waikiki Aquarium, published *Hawaiian Fishes*, a volume with many illustrations which is now out of print.

Much of the ichthyological interest in recent years undoubtedly stems from the efforts of Vernon Brock, former director of the Hawaiian Division of Fish and Game, who about 1945 started to build annotated keys to all the fishes of the Islands. Some of the material contained in these keys came from knowledge Brock and his colleagues gained through pioneer use of what at that time were considered ingenious methods of collecting with self-contained diving gear, poisons of various kinds, siphons, etc. For several years the only up-to-date material for investigators working on the Eastern Pacific fauna consisted of these mimeographed keys. It may be noted that Brock developed the method of using diving transects across a reef, which provided excellent material on reef fish biology and also gave us the first population abundance figures for such sections.

In 1948 Dr. William Gosline joined the faculty of the University of Hawaii and began a series of studies on various groups of Hawaiian fishes. Later he and Brock teamed up, and, with the help of colleagues and graduate students, produced a much-needed *Handbook of Hawaiian Fishes* which was published by the University of Hawaii Press in 1960. In their introduction to the 584 native fishes in the Hawaiian fauna, the authors point out that "the greatest need in the taxonomy of the Central Pacific fishes today is more adequate biological knowledge." Ichthyologists are in agreement that this urgent need applies not only to Hawaiian fishes but to most other kinds as well. Hence the investigations being carried out at the University of Hawaii's Marine Laboratory at Coconut Island as well as those of the U.S. Bureau of Commercial Fisheries, Honolulu Biological Laboratory (formerly POFI, now BLH) are of considerable importance.

ICHTHYOLOGY IN THE HAWAIIAN ISLANDS

↑ Mr. Hobson and Dr. Tester examine two of the Coconut Island fish tanks.

← Drs. Helfrich, Banner, and Satoshi (*left to right*) with *Lutjanus bohar*, the principal form studied in the poisonous fish investigation going on at Coconut Island.

← Gosline's fish house. The signs are put up to hold the building together. (Photos by Masao Miyamoto)

Recent studies at the Marine Laboratory under Dr. Al Tester, Dr. A. H. Banner, Dr. Phil Helfrich, and others have done much to unravel the biology and life history of a number of the important shallow-water fishes. Other experimental studies have dealt with such vital problems as shark repellents and the factors involved in the transmission of tropical fish poisoning.

The laboratory of the U.S. Bureau of Commercial Fisheries, on the University of Hawaii campus, maintains research vessels whose routine cruise routes have covered much of the eastern and central Pacific. The numerous contributions of this laboratory in the field of oceanography, especially with relation to the biology of the pelagic fishes, have provided new insights into the food resources of the region.

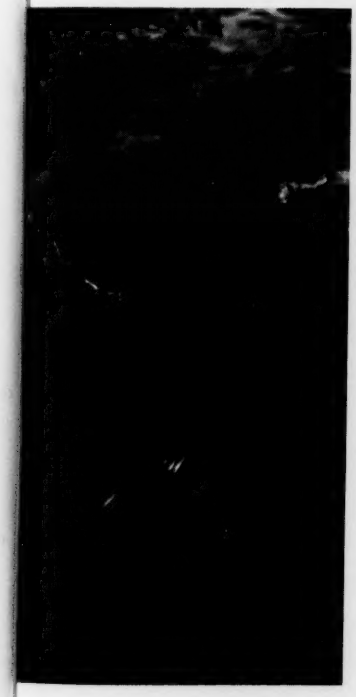
The ability of an investigator to do good systematic work is largely dependent upon having adequate reference material available. In Honolulu there are three basic fish-reference collections. The oldest, that of the Bishop Museum, is quite valuable in that it contains a great deal of material upon which publication has been made; however, the collection is static at present since the Museum has limited funds and does not have a staff ichthyologist. A small but increasingly valuable collection has been accumulated at the U.S. Bureau of Commercial Fisheries Honolulu laboratory; although very little has been published on these eastern and central Pacific collections, they are now being studied by Dr. D. W. Strasburg as a part of a program on the taxonomy and ecological relationships of the fishes that make up the oceanic community in which the tunas live.

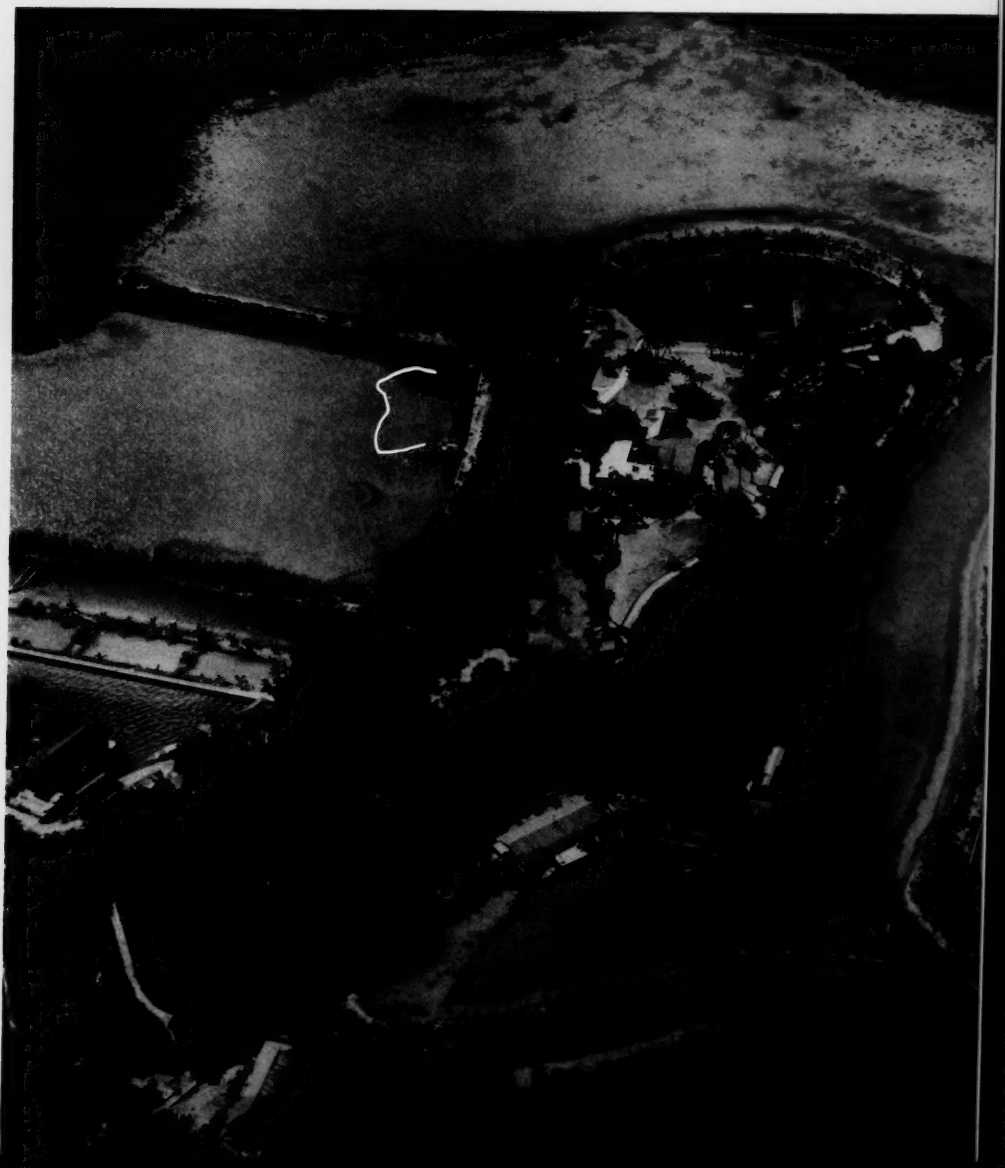
The largest and most-used fish collection is housed in a temporary war-time building on the campus of the University. Although the University is now constructing a new zoölogy building with storage space for the present collection, what is actually needed is an entirely separate new structure devoted to the housing of the three collections described above. This has been suggested at various times by informal proposals, and it is hoped that before too long the Hawaiian state government will be able to provide matching funds so that with aid from the National Science Foundation or other group, the best ichthyological laboratory in the country can be built on the campus; this laboratory could then serve as the regional depository for all reference material from the central and eastern Pacific.

In summation, the outlook for the future of Hawaiian ichthyology and its offshoot, fisheries biology, is extremely promising. This is quite pertinent since economists tell us that the future food for our exploding populations must come from the sea.

Biological Laboratory, U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, on the campus of the University of Hawaii. (Official Photograph, Fish and Wildlife Service)

Coconut Island, in Kaneohe Bay, windward—east—side of Oahu. Buildings and docks of University of Hawaii's Marine Station are at lower right. Rectangular experimental tank, just below left center, held for several months the only hammerhead shark ever kept in captivity. (UH photo, Camera Hawaii)





Schooling skipjack tuna photographed from special observation port built into the hull of one of the BLH research ships operating in the central and eastern Pacific. (Official Photograph, U.S. Fish & Wildlife Service)

(See cover and page 16 of PD, *July–August 1960, for better examples from this remarkable series of undersea photos.)*

SQUEAKING for birds has now been made easy (the physical part, that is) by the Audubon bird call. It used to be necessary to work rather hard at it to get results but occasionally a little squeaking in the right place at the right time brought phenomenal results. I recall such an occasion in a *kipuka* (a small wooded area isolated and surrounded by lava flows) high on the slopes of Mauna Loa on the island of Hawaii. I had started out at daybreak from an army rest camp and mid-morning found me seated with my back against a large Ohia Lehua *(Metrosideros polymorpha)*. The growth in the *kipuka* was somewhat dense but from where I was seated I had a good view up into several shrubs as well as other lehua trees. A passing flash of red impelled me to try my luck at squeaking. To my astonishment birds moved in from all sides and perched in the bushes surrounding me and looking at me just as in the Walt Disney cartoons where all the wildlife gathers around the small boy lost in the woods. I continued squeaking until my lips were tired and sore and in a short time saw more native birds than I had been able to spot on Oahu in a year. The red flash proved to be an Apapane but the Iiwi also showed up. Among the others that stopped by to watch the bird-watcher were the Elepaio, Amakihi, Akiapolaau, and the Omao. Reluctantly I finally stood up and made my way back to the barren trail up the mountain.

I don't believe that I have ever seen the value of a nature hobby or even just a casual interest in nature demonstrated more clearly than in Hawaii during World War II. As a censor of navy mail for a year and army mail for another year I came to know all too intimately the thoughts of a large number of sailors and soldiers. I don't think it would be any great breach of confidence at this time to say that the great majority of them were unhappy. In fact, very unhappy. They found Hawaii utterly and completely boring. The most common complaint was that there was absolutely nothing to do on a day off.

This was in sharp contrast to the relatively few who looked forward eagerly to their day of "liberty"—for it meant another opportunity to get acquainted with the fascinating flora and fauna of Hawaii. One time it might be a hike to the top of Mount Kaala, high in the Waianae Mountains, looking for native birds and collecting native plants or insects and another time a search for cowry shells at a distant beach. Or in town a visit to Honolulu's Bishop Museum was always worthwhile. And, too, the most beautiful tropical flowering plants of the world could always be studied in the streets and gardens of Honolulu. There was simply no end to the list of interesting activities available for the nature-minded visitor in uniform. The men who took advantage of these opportunities returned to camp refreshed and full of enthusiasm. Others, many of whom spent the day standing in line for a bottle of beer, continued complaining about everything imaginable.

Of course the same principle operates in peacetime as well. The tourist who spends most of his time in a Waikiki bar is not going to develop much appreciation for Hawaii and things Hawaiian. But for the naturalist a trip to Hawaii can truly be a trip to "Paradise."

For help in identifying Hawaiian birds consult:

A Field Guide to Western Birds. By Roger Tory Peterson. Houghton Mifflin Co., Boston. 1961.

Birds of Hawaii. By George C. Munro. Charles E. Tuttle Co., Rutland, Vermont. 1961.

Hawaiian Birds. Hawaii Audubon Society, Honolulu, Hawaii. 1959.

In studying nature at Hawaii's beaches see:

Reef and Shore Fauna of Hawaii. By Charles Howard Edmondson. Bernice P. Bishop Museum, Honolulu, Hawaii. 1946.

A Field Guide to the Shells of the Pacific Coast and Hawaii. By Percy A. Morris. Houghton Mifflin Co., Boston. 1952.

Handbook of Hawaiian Fishes. By William A. Gosline and Vernon E. Brock. University of Hawaii Press, Honolulu, Hawaii. 1960.

For guidance in finding the names of Hawaii's beautiful trees and flowers try:

Hawaiian Flowers and Flowering Trees. By Loraine E. Kuck and Richard C. Tongg. Charles E. Tuttle Co., Rutland, Vermont. 1958.

Hawaii Blossoms. By Dorothy and Bob Hargreaves. Hargreaves Industrial, Portland, Oregon. 1958.

Excellent background information on Hawaii can be found in:

The Hawaiian Chain. By E. H. Bryan, Jr. Bishop Museum Press, Honolulu, Hawaii. 1954.

For comprehensive and authoritative though technical manuals on Hawaiian insects consult:

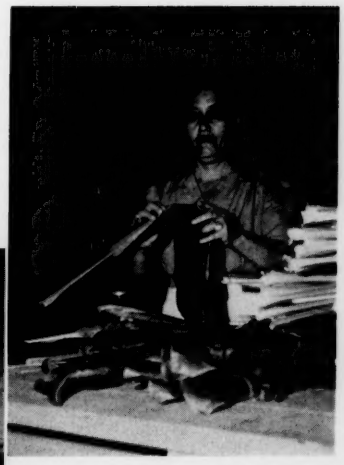
Insects of Hawaii. By Elwood C. Zimmerman. University of Hawaii Press, Honolulu, Hawaii. 1948–1961.

Volumes I–VIII and X have now been published. Volume X, on Diptera is by D. Elmo Hardy. Volume I constitutes an excellent general introduction to Island biology. Other volumes have covered the Heteroptera, Homoptera, Ephemeroptera, Neuroptera, Trichoptera, Lepidoptera and minor orders.

Waianae Mountains, Oahu—leeward or western side. Mt. Kaala, 4,025 feet (center, opposite page), is Oahu's highest peak. (5-neg. composite, 8x10 view camera)

➔ Preparing ti leaves for many uses at a luau, including hula skirts.

↓ Ti leaves are the all-purpose wrapping paper of the Islands, and (*below*) make a beautiful tablecloth. (See also page 23.)



➔ The ti plant grows to 15 or 20 feet.

(All photos by A.C.S.)

WATCH FOR——————Ti Plants *(Cordyline terminalis)*

BROUGHT to Hawaii in the canoes of the early Polynesian voyagers, ti now grows wild in many of Hawaii's lower forests. It is also a common garden plant and is sometimes cultivated as a house plant as well. You will see ti leaves everywhere in Hawaii for they are used for many purposes. The true Hawaiian "grass" skirt is made of ti leaves. The large leaves are used at the luau for table cloths, plates, and food wrappers and the tender, young leaves serve as a kind of "spinach" cooked with meat inside of large ti leaves. And the root of this versatile plant is also used. Liquor from the boiled root is fermented and distilled to make *okolehao. Okole maluna!*

Twilight Around the World

AT SUNSET when the last fiery blade of the sun's reddened disc is engulfed by the horizon, there lingers the glowing light of evening often streaked with the red and gold of sun-touched clouds. The light fails, the color deepens and shadows form among the clouds turning some of them dark and gray against a green and sapphire sky. Finally darkness rises out of the east and gives life to the stars.

The time between sunset and darkness and a corresponding period in the morning is known as twilight. The question of just when darkness falls in the evening or the first light of morning becomes perceptible is a difficult one to answer. The duration of twilight often becomes of important significance in legal actions, for it involves the ability of persons to see in the failing light of evening or the growing light of morning. The changing value of the illumination owing to the depression of the sun below the horizon can be easily computed, but the true value of the illumination is greatly affected by local conditions such as the cloudiness of the sky and the height and nature of the horizon. This leaves the question of visibility still unsettled.

There are three periods of twilight which men have defined upon an arbitrary basis. The astronomer is interested in the time when the last bit of sky illumination from the sun has disappeared. This occurs when the sun is about 18 degrees below the horizon. This value of 18 degrees has been adopted as the criterion for defining *astronomical twilight.* When the earth has turned sufficiently in the evening so that the sun is 18 degrees below the horizon, astronomical twilight is said to end. The navigator is interested in the period during the evening or the morning when there is light enough to see the horizon, but it is dark enough to see the brighter stars. This condition prevails when the sun is about 12 degrees below the horizon. *Nautical twilight* ends in the evening when the sun is 12 degrees below the horizon. The third period of twilight is that defined as ending when the sun is 6 degrees below the horizon and is called *civil twilight.* Automobile headlights become essential for driver visibility at that time.

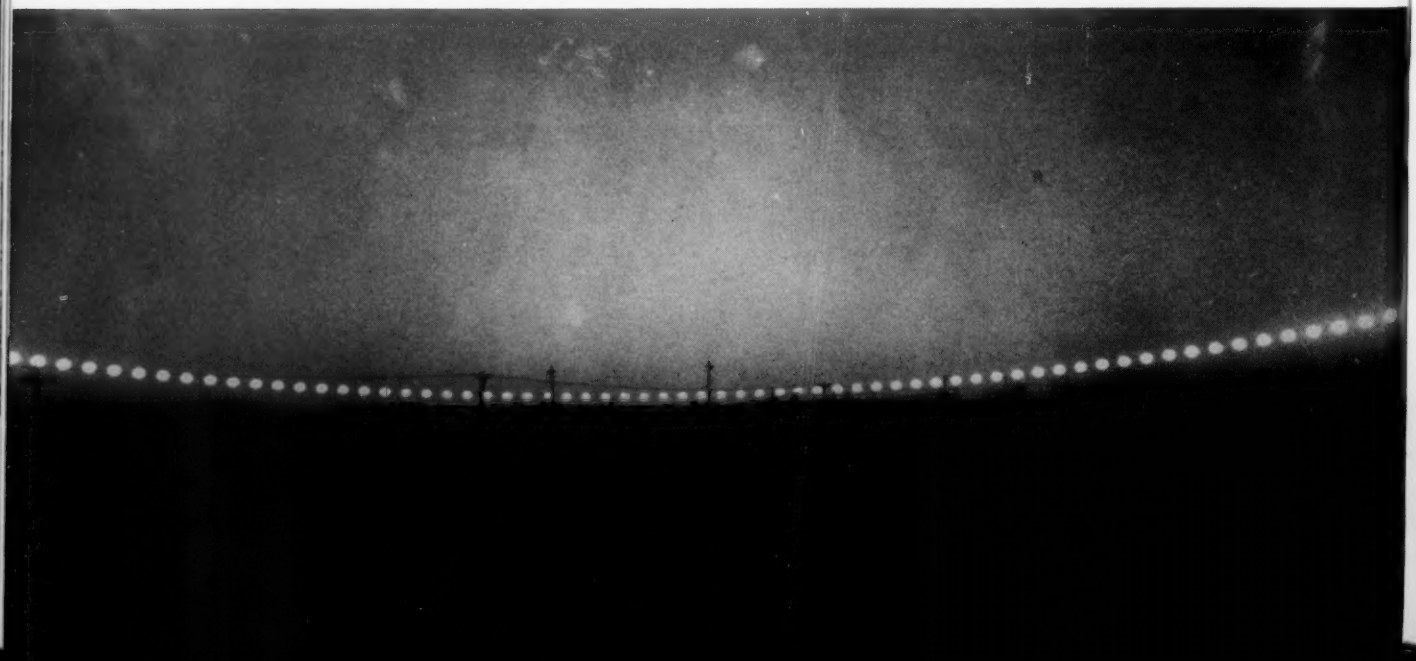
Next we ask how long before sunrise or after sunset do these conditions exist? The earth turns at a constant rate of 15 degrees per hour, but at the end of an hour after sunset the sun is not necessarily 15 degrees below the horizon. Only at the Equator does the sun sink vertically toward the horizon, so at the Equator astronomical twilight ends 18/15 hours or 1 hour and 12 minutes after sunset. There are slight variations from this during the different seasons, but these are so small that they can be disregarded.

At all other places on the earth the sun approaches the horizon obliquely, the angle depending upon the latitude of the place. This oblique motion slows the setting of the sun and increases the time required for it to reach the required distance below the horizon for the ending of twilight. The farther from the Equator, the greater is this effect.

Visitors to California often remark about the short period of twilight, particularly in southern California. But if the difference is noticeable to them, they surely come from a place having a higher latitude than ours. For example, New York City is at latitude 40° 30′ north, Chicago is 42° north, and Detroit is 42° 30′ north. San Francisco is at latitude 37° 30′ north and Los Angeles only 34° north. Visitors to the tropics find this difference even more noticeable.

The sun's motion across the sky is a reflection of the rotation of the earth on its axis. During the year the sun moves north and south in the sky as a result of the motion of the earth around the sun and the fact that the earth is tilted on its axis. When the earth is on one side of the sun its Northern Hemisphere is tilted in the direction of the sun, and on the other side of the sun the Southern Hemisphere is tilted sunward. The diagrams illustrate the daily paths of the sun at different northern latitudes at the dates of the beginnings of the four seasons. One diagram illustrates the conditions at the Equator and cannot be considered a northern latitude. Of course the same situations apply in the Southern Hemisphere except that the seasons are reversed.

From these diagrams it is easily seen that the earth must turn much farther to place the sun 18 degrees



Conducted by George W. Bunton and O. Richard Norton

below the horizon at high latitudes than is necessary at the Equator or within the tropics. Also one may see that there is a greater difference in the number of hours of sunlight through the year at higher latitudes. One may see that the sun is above the horizon exactly half the time all through the year at the Equator, producing 12 hours of daylight and 12 hours of darkness. It may also be seen that for at least one day of the year the sun remains above the horizon for 24 hours at latitudes above the arctic circle, hence "the land of the midnight sun." G.W.B.

SKY DIARY

September, October, November, 1961
(All Times are PACIFIC DAYLIGHT SAVING TIME)

Phases of the Moon

Last Quarter	September 1	**4:06 P.M.**
New Moon	9	**7:50 P.M.**
First Quarter	17	**1:24 P.M.**
Full Moon	24	4:34 A.M.
Last Quarter	October 1	7:10 A.M.
New Moon	9	11:53 A.M.
First Quarter	16	**9:35 P.M.**
Full Moon	23	**2:31 P.M.**
Last Quarter	31	1:59 A.M.
New Moon	November 8	2:59 A.M.
First Quarter	15	5:13 A.M.
Full Moon	22	2:44 A.M.
Last Quarter	29	**11:19 P.M.**

The Planets

Mercury: is well placed for observation in September. It appears in the evening sky some 26° east of the sun on September 29 and sets almost two hours after the sun.* This favorable elongation will afford a good opportunity to see this elusive planet. Mercury arrives at inferior conjunction by October 22 and is lost in the sun's glare throughout the remainder of the month. On November 7, Mercury appears in the morning sky. At that time, its greatest elongation west is only 19° and therefore is unfavorably placed for observation.

Venus: is a brilliant object in the morning sky in September rising about three hours before the sun. It is proceeding toward superior conjunction with the sun during these three months. Its angular distance west of the sun decreases from 35° in early September to only 15° by the end of November when it will be lost in the sun's glare. Its magnitude remains constant at −3.4.

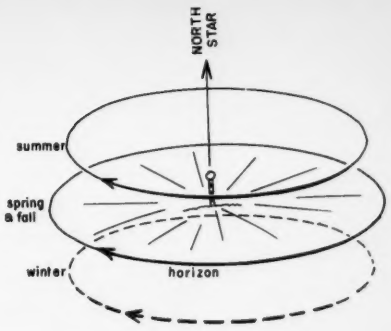
Earth: reaches heliocentric longitude of 0° on September 21 marking the first day of autumn in the Northern Hemisphere and spring in the Southern Hemisphere. At this time, the sun is directly overhead for observers at the Equator.

Mars: eastward motion through Virgo is not rapid enough to prevent the sun from overtaking it. By the end of September, it will be setting in the evening twilight only one hour after sunset. Through October and November, Mars will be so close to the sun it will be hard to see.

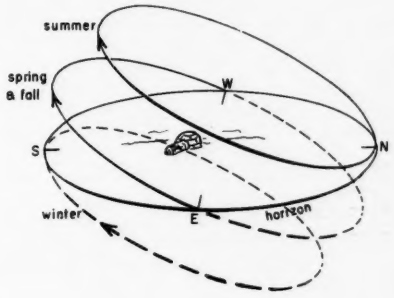
Jupiter: rises about an hour before sunset in early September. On September 23 it is a stationary object in Sagittarius. Eastward motion is resumed throughout October and November. In late October, Jupiter enters Capricornus where it will remain throughout the year.

Saturn: is found in Sagittarius through these three months. It is in retrograde motion until the end of September but takes up its regular eastward motion on September 27. The angular distance between Jupiter and Saturn is slowly increasing because of Jupiter's more rapid eastward motion. Twenty years will go by before these two planets are again close to each other.

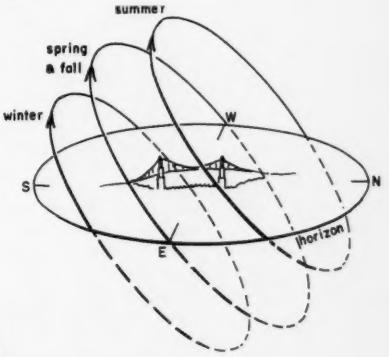
* An error was made in the Sky Diary for July-August. It stated that Mercury reaches greatest eastern elongation of 26° on August 29. It is September 29 as stated in this issue. O.R.N.



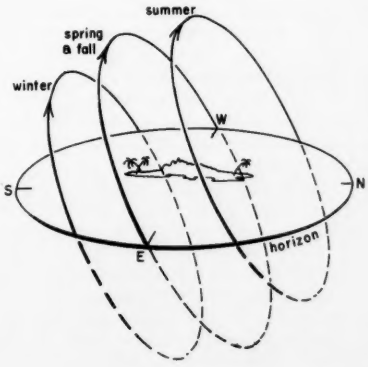
→ At the North Pole. The sun spirals slowly upward to a maximum of 23.5° above the horizon on the first day of summer, but its path is essentially the same height above the horizon (or below) all day long on any day of the year. On the first day of spring and fall the sun follows the horizon all the way around during 24 hours.



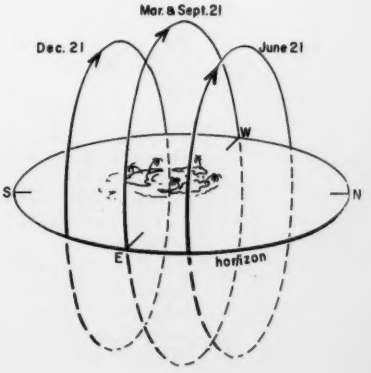
← On the Arctic Circle. The sun just touches the northern horizon at midnight on the first day of summer, and does not rise on winter's first day.



→ In San Francisco, latitude 37°30′.



← In the Hawaiian Islands. The sun's path is tilted 21° from the vertical.



→ At the Equator. Dates were used here since the seasons have little meaning at the Equator.

The midnight sun at Point Barrow, Alaska, approximate latitude 71°15′N. The disc was snapped every four minutes from 10:15 P.M. to 3:25 A.M., 12–13 May 1957 at 1/200 sec. (Photograph by A. R. Franzke; print by Marshall Schalk; see *PD*, May-June 1958 for doublepage spread of it)

Tapa cloth to temple courts

Arts and Crafts of Hawaii. By Te Rangi Hiroa (Peter H. Buck). Bernice P. Bishop Museum Special Publication 45. Published by the Bishop Museum Press, Honolulu. 1957. xv + 606 pp., 350 text figures in halftone and line, decorative endpapers. $12.00.

Director of the Bishop Museum from 1936 till his death in 1951, Te Rangi Hiroa, also Sir and Dr. Peter H. Buck, left it to the able hands of his successor, Dr. Alexander Spoehr, and the Museum staff to prepare his just completed manuscript of *Arts and Crafts of Hawaii* for the press. One cannot believe that the distinguished New Zealander—half Maori, half Irish, physician, anthropologist, leading representative in his time of the Polynesian race to which he felt principally attached—could have been in any significant degree dissatisfied with his last great work as it was finally published. Into the posthumous processing went not only the skill of many hands, the knowledge of many minds, and the linings of many pockets (such a book is costly in the extreme, and this one is handsome and generous without being extravagant), but the love and respect of all concerned for their late colleague and friend.

As Dr. Spoehr points out in his Foreword, this study of the material culture of Polynesia as focused on Hawaii "is more akin to the contemporary archaeological report than to the ethnological study," and its purpose most understandable to archeologists. In fact, the spadework in the Islands which Dr. Spoehr and Dr. Emory have briefly mentioned in this issue has in effect taken up the study where Dr. Buck left it, and of course much has come to light which the late Director would have incorporated into the book had he lived a few years more. It is nevertheless in every sense monographic if not definitive.

In Te Rangi Hiroa's book, every phase of living was part of the material culture of his maternal people and therefore contributive to their arts and crafts. Thus the main headings are found to be: food, houses, plaiting, twined baskets, clothing, canoes, fishing, games and recreation, musical instruments, war and weapons, religion, ornaments and personal adornment, death and burial. In these larger categories one will find an astounding array of subdivisions and sub-subdivisions, each giving rise to some product of the skilled hand, and in toto sufficient to dispel forever from the supposedly more sophisticated mind any notions about the "simple" life of the Island native. In its own way this life was a sophisticated and successful coping with natural facts and phenomena with a minimum of material resources and a maximum of ingenuity and creative imagination. The study of the objects of this culture is fascinating and endlessly rewarding; and even such a large and eminently authoritative work as this represents, shall we say, a well developed outline.

All the Pacific's best

Hawaii 1961. By William W. Davenport and others. Foreword by James A. Michener. Edited by Eugene Fodor. Fodor's Modern Guides. David McKay Company, Inc., New York. 1961. 315 pp., illus. in color, halftone, and line. $4.25.

Some travelers would not be caught dead with a guide book, preferring to make their own discoveries (and mistakes), or perhaps especially not wanting to look like tourists (this kind might cheat, having the book but never taking it out of his hotel room). Others there are who would perish without a guide—the extremists among them will grind to a dead stop in the middle of anything to look up what the next forward or sideways move should be, or will shout across streets, dining rooms, or museum halls to other members of the party, "It says here in the guide. . . ."

If a bad or far out-of-date guide is worse than none, a good guide should be a manifold blessing. Mr. Fodor's *Hawaii 1961* looks good from where we sit and think back to the visit of three years ago. In fact, I'm sure that having such a handbook then would have gained us much from our hurried touring. Perhaps the usual way to review a travel guide is to spot check what you know in a few selected cases; and if you can't point in triumph to an error, it is a reliable guide. Leaving Fodor's reputation in two hemispheres to speak for itself, it might be noted here with pleasure that this one is not dull; it seems designed for the armchair at home as well as for the backseat driver's seat on the road to Punaluu. Not only lively, it is jampacked, and I intend to take it with me to the Tenth Pacific Science Congress this August.

It was a good stroke to get James Michener up front. The juices begin to flow in one's mouth, reading his "eight most cherished things to see in Hawaii: . . . the volcanoes on the Big Island when they are covered with snow; boats returning to shore as dusk falls upon Lahaina; the thousand waterfalls that tumble down the cliffs of Molokai after a rain; red Waimea Canyon on Kauai, especially when the late afternoon sun is upon it; the lava flows on the Big Island; the view from the Nuuanu Pali; the lights of Honolulu as you see them from the top of Wilhelmina Rise; those are the first seven. The eighth should be whatever scene happens to strike the imagination of the visitor. For me . . ."

All the Best in the South Pacific: *Tahiti, Samoa, Fiji, New Caledonia, New Zealand, Australia.* By Sydney Clark. Dodd, Mead & Company, New York. 1961. xi + 334 pp., photos, endpaper maps. $4.95.

"A Sydney Clark Travel Book" by the author of *All the Best in Hawaii* (a new 1961 edition is on store shelves as we go to press), *All the Best in Scandinavia,* and *All the Best in*—you name it, this one covers just about everything in the South and Southwest Pacific presently accessible to or interesting to tourists. It is a very different cup of tea from the preceding—Fodor—guide. Indeed, it might be termed not so much a guide as a travel book. It starts by *looking* more like an ordinary trade book; then it does not have the clutter of small-type and double-column sections that enable Mr. Fodor to "give you the works." Yet Mr. Clark in his own more literary way does pack in much detail about hotels, eating-places, and transportation. He obviously prefers first class everything, and thereby has missed some experiences, the kind most tourists prefer to miss, no doubt. But it is nostalgically refreshing to the memory to read his descriptions of—pardon the place-dropping—Perth, Western Australia's delightful capital, or Wakitipu, New Zealand's longest lake. Mr. Clark is a thoughtful traveler, not a skimmer, and gets a good deal of the feel and background into his unhurried views of the places he knows. Another thing to recommend him is that he seems content to leave out what is not of his own experience—or, as in the case of Alice Springs, for instance—give a bit he has learned and let you know this is on his agenda for "next time." His remarks on Australian airlines are on the beam; and I agree most heartily that in New Zealand you must get a little car and hit the road in fancy-freedom.

The Hawaiian Book: *Story of Our Island Paradise.* (Selections) edited by Thomas C. Jones. J. G. Ferguson Publishing Company, Chicago. 1961. 337 pp., profusely illustrated in color, halftone, and line. $9.95.

What critical approach can one possibly take to a big, brassy medley, a riotously seasoned smorgasbord, a bargain-counter scramble of last year's gaudiest muumuus, aloha shirts, and jumbo full-color postcards?—wild are the metaphors inspired by this extravagant scissors-and-paste-pot collage between hard covers, but the thing somehow adds up to a titillating treatise on State 50, a place which, it seems, must certainly overlap if not supersede Cloud Nine. That the book adds up and not down is due in good measure to the intrinsic merict of many of its sources and the stature of a number of its first-hand contributors. These include *Paradise of the Pacific,* the *Encyclopedia Britannica, The Hawaiian Kingdom* by Kuykendall, *Hawaii's People* by Lind, and such Bishop Museum authorities as Alexander Spoehr, Kenneth Emory, and E. H. Bryan, Jr. Whopping sampler, exhibition piece, king-size statehood souvenir—whatever it is, you will find it exciting and full of information about everything Hawaiian under the tropic sun.

Hawaii, the Aloha State. By Helen Bauer. Doubleday & Company, Inc., Garden City, New York. 1960. 192 pp., illustrated in halftone and line. $3.50.

From its general look, feel, and tone, you would not guess that this sound construction of history and geography by a writer of several such books was put together for the 8–12 age bracket. History runs here "From Kingdom to Statehood," geography looks at "American Hawaii: Its Land and People." You may get it for a favorite 10-year-old, but you will probably read it yourself first.

The air we live in

The Ocean of Air. By David I. Blumenstock. Rutgers University Press, New Brunswick, New Jersey. 1958. xiii + 457 pp., numerous charts. $6.75.

His brief bit in this issue is barely a hint of what is in store for the reader of David I. Blumenstock's big book, *The Ocean of Air.* Everybody talks about the weather; Dr. Blumenstock, the U.S. Weather Bureau's Pacific Area Climatologist, is one of the few who can do something about it, and one of the very few who can write about it not only with high level authority but with style, wit, and unfailing clarity. Far more than merely a weather book, this is in fact a full-round rendition and interpretation of the facts about the earth's total atmospheric envelope, from its global under-surface with its endless sea-land-air water cycle, to its outermost attenuation in the stratosphere. All of this is infinitely worth knowing about and understanding, for without it of course no life as we define it would exist; and Dr. Blumenstock has made the partaking of this mental fare a feast. But in order to give it all the fullest possible meaning for our time, he could not in conscience fail to include some chillingly cold turkey. In dealing with the role of weather and climate in the life of man, he has gone at length into questions of weather in relation to nuclear warfare. "The wind bloweth where it listeth," and fallout makes no distinctions. . . . In this chapter a sober scientist is in effect speaking out, with everything he knows, against the ultimate insanity.

Of the air and water worlds

Living Fishes of the World. By Earl S. Herald. A Chanticleer Press Edition. Doubleday & Company, Inc., Garden City, New York. 1961. 304 pp., profusely illustrated in full color and halftone. $12.50.

Another author of this issue who has recently come forth with a major book in his special field is the Curator of the Steinhart Aquarium of the California Academy of Sciences. Dr. Earl S. Herald's *Living Fishes of the World* takes its place in the distinguished and handsomely produced World of Nature series Doubleday is issuing under the Chanticleer imprint. One of the most popularly appealing, scientifically interesting, and vitally important to man throughout human history, of the major animal groups, the fishes are treated here in systematic order under the main classes of the jawless, the cartilage, and the bony. Practicing research biologist and systematist though he is, Dr. Herald does not forget the wide and fact-thirsty public he is primarily writing for—and who better than the director of one of our biggest aquariums knows what the public wants to know about fish? He has at the same time made the most of a superb assemblage of full-color and black-and-white photographs by the best lensmen in the business around the watery world.

Birds of Hawaii. By George C. Munro. Color illustrations by Y. Oda. Bridgeway Press: Charles E. Tuttle Company, Rutland, Vermont, and Tokyo, Japan. Revised edition, 1960. 189 pp., 20 full-color plates, halftone photographs. $4.50.

Since it was first published in 1944, Munro's *Birds of Hawaii* has won its place for completeness and reliability, has been sold out, and constantly sought after in the bookshops. Its reissue, with some illustrations replaced and with a table of nomenclature changes added, was a must and comes at a time of fast-growing interest in everything Hawaiian. The same Scott Wilson work, *The Birds of Hawaii* (1899) that gave us the three halftones on pages 6 and 7 here also furnished the source material for many of Oda's color plates in *Birds of Hawaii*. D.G.K.

Oceanography. Invited lectures presented at the International Oceanographic Congress held in New York, 31 August–12 September 1959. Edited by Mary Sears. Publication No. 67, American Association for the Advancement of Science. Washington, D.C. 1961. 665 pages, 146 figs. $14.75 (for AAAS members, $12.50).

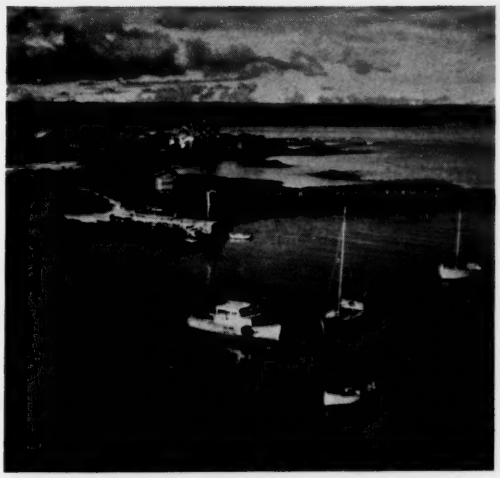
It is often said that oceanography had its official beginning on that December day in 1872 when the *Challenger* set sail from Portsmouth. Be that as it may, certainly the coming out party for oceanography was staged from August 31 to September 12, 1959, at the United Nations, when nearly 1,200 scientists assembled in New York for the first International Oceanographic Congress. Hundreds of papers were given during this two weeks, with concurrent and overlapping sessions, and no one could possibly hear or understand them all, so varied and complex are the interests of different kinds of oceanographers. During each morning of the Congress, however, invited summary lectures were presented to the entire Congress (and not everyone listened to all of these). This book contains these lectures, all in English, and while there can never be a complete record of all that was said and done at a meeting of this type, the book will provide many who could not attend with a good idea of what is being accomplished in oceanography. This has become an important subject, deliberated upon by congressional committees, and those of that admirable company of general readers who like to dig beyond the shallow depths of popular accounts will find many of the articles interesting and profitable reading, for they were intended to provide information for those specializing in other aspects of oceanography than the immediate phase being discussed. There are thirty lectures, arranged under five topics: the history of the oceans, populations of the sea, the deep sea, boundaries of the sea, and cycles of organic and inorganic substances in the ocean. The speakers came from ten countries, including the Soviet Union, and while opinions and interpretations may have differed, the common bond that brought them all together was man's curiosity about the sea. J.W.H.

Between two worlds

Living Amphibians of the World. By Doris M. Cochran. A Chanticleer Press Edition. Doubleday & Company, Inc., Garden City, New York. 1961. 199 pp., 77 full-color, 143 halftone photographs. $12.50.

Latest in The World of Nature Series is this one by the Curator of Reptiles and Amphibians of the United States National Museum, Smithsonian Institution. It matches up in every way to its distinguished predecessors, and should go a long way towards overcoming a rather widespread repugnance or at least a general apathy respecting the "slimy creatures" that represent the evolutionary link between the fishes and all higher vertebrates. One whose interest is captured—by such a book as this if not by chance encounters with the living animals themselves—will be rewarded by the discovery of some of nature's most remarkable, and colorwise beautiful, forms, whose natural history is replete with wonder.

academically speaking



Academy Bay, Indefatigable Island, Galápagos; Charles Darwin Research Station. (Robert I. Bowman)

In view of the Academy's long standing interest in the Galápagos Islands—with over 2,200 pages dealing with Galápagos science already printed—your regular columnist, Hal Richardson, has asked me to report on recent developments concerned with these famous "Islands of Evolution."

During the Tenth Pacific Science Congress in Honolulu this year (see this column for July-August 1961) scientists from around the world will convene for purposes of discussing the problems of the Pacific area. Among those attending will be authorities on the Galápagos who will participate in the first international symposium of its kind to deal specifically with Galápagos science. This special meeting, organized by the undersigned, will serve several functions, chief among which are the following: to call attention to the varied research opportunities on the islands; to dispel the rather wide-spread misconception that Galápagos is a well-studied region; to provide, through the published proceedings, guide lines for future research; to draw attention to the increasing threats to survival of the number of unique species of plants and animals, about whose biology we are almost totally ignorant; and to stimulate Congress participation of scientists from Latin America.

Some of the topics to be discussed are "Bathymetric setting for the Galápagos" by Dr. George Shumway; "Physiological adaptations of higher vertebrates to marine conditions" by Dr. Knut Schmidt-Nielsen; "Archeology of Galápagos" by Dr. Thor Heyerdahl; "Conservation problems in the Galápagos" by Dr. M. Acosta-Solis; "Biological Evolution on Pacific islands" by Dr. Theodosius Dobzhansky; "Biosystematic studies on Galápagos tomatoes" by Dr. Charles Rick; "The marine fishes of Galápagos" by Dr. Boyd Walker; and "The future of scientific studies in the Galápagos" by Dr. Victor Van Straelen.

Dr. Van Straelen, the distinguished biologist from Belgium, is President and founder of the recently formed Charles Darwin Foundation for the Galápagos Islands. Many years he has spent in promoting the cause of wildlife conservation and national parks in the Belgian Congo. The Charles Darwin Foundation is primarily concerned with the implementation of the 1934 and 1958 legislation by the Government of Ecuador, designed to give protection to and encourage research on the Galápagos biota.

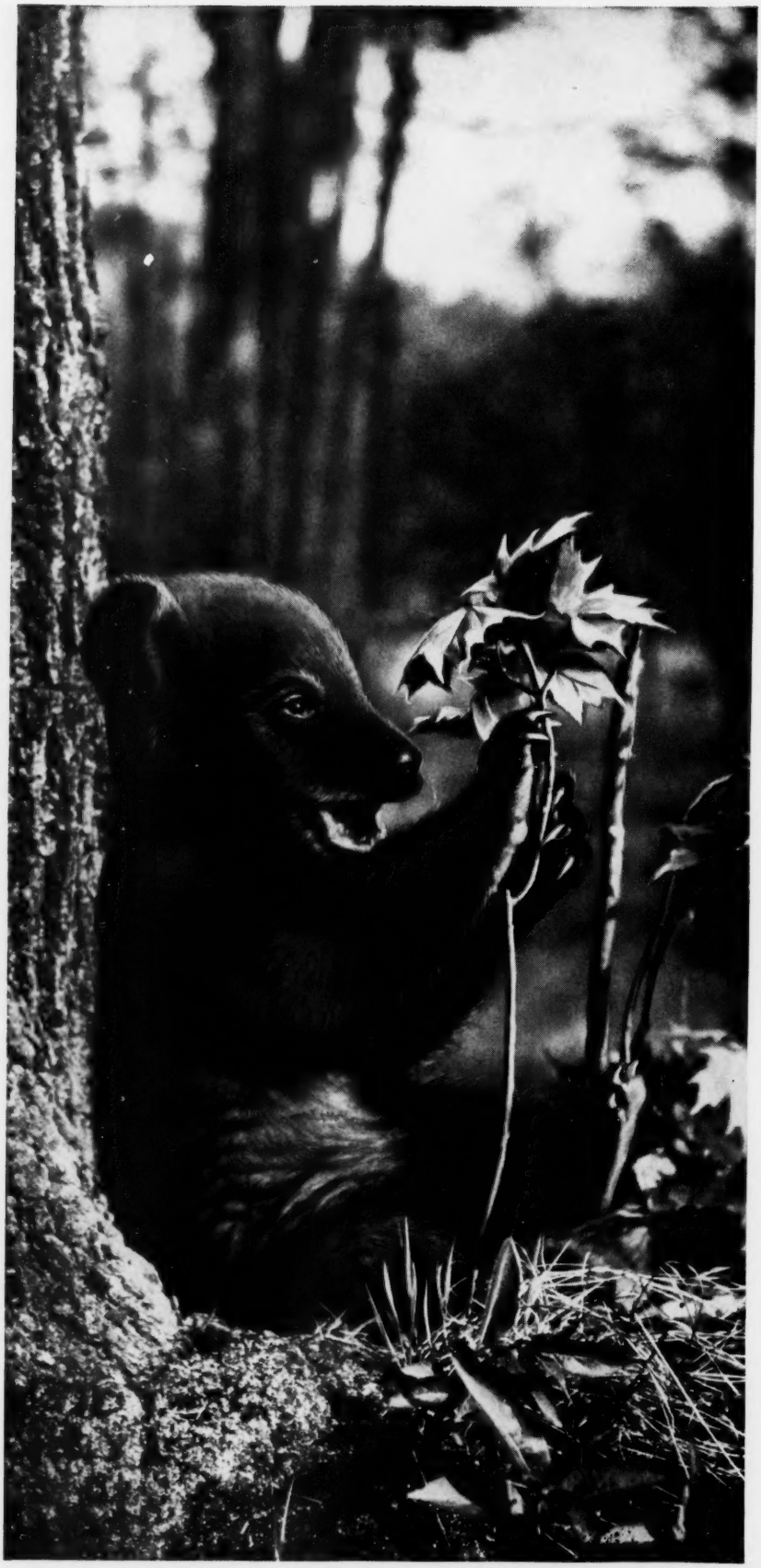
The important role that the Academy has played in the drafting of the first conservation laws for Galápagos is relatively little known. During the early 1930's, Mr. Harry S. Swarth, late curator of the Department of Birds and Mammals, and monographer of the Galápagos (Darwin's) finches, was asked by the late Dr. Robert T. Moore of Occidental College to submit information on Galápagos species in greatest need of protection. This information, carefully selected from the Academy's extensive files of field observations, formed the basis of the recommendations that resulted in the 1934 Executive Decree. The Presidential Proclamation authorized the future establishment of a research station in Galápagos, and this important idea originated with Mr. Swarth. Although since 1934 many efforts have been made to promote a research station on the islands, it was not until this year and under the leadership of Dr. Van Straelen of the Darwin Foundation and Mr. Alain Gille of UNESCO, with the full coöperation of the Government of Ecuador, that a research installation has become a reality. Nearing completion are several buildings including a large laboratory, living quarters, and service areas. The opening of the "Charles Darwin Research Station" later this year will mark a milestone in international conservation. This will be the first international scientific laboratory for research on the natural resources of a specific region. The California Academy of Sciences is giving its full support to this worthwhile project through this writer who serves on the Executive Council of the Charles Darwin Foundation.

Of special interest to the Academy is the fact that the station is located on Indefatigable Island at Academy Bay, an anchorage named in honor of the research schooner *Academy* from the California Academy of Sciences, almost two years in Galápagos waters during 1905–06.

When the Darwin Research Station is fully operative, the Foundation expects to attract scientists from all quarters of the globe to study various unique and basic problems of biology, oceanography, and climatology that occur in Galápagos. As a result of such investigations it is hoped that there will be more effective management of rare and unusual plants and animals, and that plans for an expanded colonization of the islands will take into consideration the recommendations of the Darwin Foundation's scientific advisory board. The citizens of Ecuador, to which country Galápagos belongs, have much to gain from the research station. Studies on the nature and distribution of the lava soils will contribute to better agricultural production on the islands; biological oceanographic studies in the surrounding waters could lead to a more effective utilization of the tuna, grouper, and shell-fish resources; through careful planning tourism could be encouraged without materially endangering the natural biota and landscape of the archipelago.

Few are the areas in the Western Hemisphere that are so little known and so widely misunderstood as the Galápagos Islands. Until 1961 the fates of the giant tortoise, the flightless cormorant, the tropical penguin, as well as other elements of the biota, were quite uncertain. Now we have every reason to feel more confident about the future of these Galápagos curiosities. The role of the Academy in this historical development is clear, and it appears certain that scientists from the Academy will be among the first to use the facilities of the Charles Darwin Research Station. We may confidently predict that future research on the natural history of these tropical islands off the west coast of South America, will lead not only to a better understanding of the local scene, but also to a fuller appreciation of the inter-relationships of all living things.

Robert I. Bowman
Research Associate



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